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THE WINONA BRIDGE, across the Mississippi River at Winona, Minn., is completed. It will be used jointly by the Chicago, Burlington & Northern, Green Bay, Winona & St. Paul, and Winona & Southwestern railways. The bridge proper is 1,260 ft long, with approaches 270 and 1,100 ft. long on trestlework. It is a modified Pratt truss of steel and iron, with curved top chord, with two spans of 240 ft., one of 360 ft and a draw span of 420 ft. The piers are of masonry, on piles. The width between centers of trusses is 20 ft. on the draw span and 360-ft. span and 17 ft. on the 240-ft. spans. The bridge was built by the Union Bridge Co., of Athens, Pa., and it was commenced Aug. 1, 1890. Mr. GEORGE S. MORISON was Consulting Engineer; D. M. WHEELER, Chief Engineer; F. K. PINGRY, Resident Engineer, and THOMAS J. LONG, Engineer for the Union Bridge Co. The estimated cost was $440,000.

AT THE WORCESTER, MASS., SEWAGE DISPOSAL WORKS experiments have been begun by Mr. C. A. MCCLURE, the Superintendent of Sewers, to ascertain if the present plant will dispose of the entire dry-weather sewage from the city. The outfall sewer leading to the basins has a capacity of 15,000,000 galls. a day, and this amount of combined sewage could be treated by increasing the number of settling basins. The dry-weather flow is about 5,000,000 galls. a day, but only 3,000,000 have been treated as yet. The City Council is estimating the relative efficiency and cost of an intercepting sewer to carry off the storm water as compared with an increased number of settling basins.

THE GROSS AND NET EARNINGS OF RAILWAYS in the United States for the month of April and the first four months of 1891, as compared with those for the same periods of 1890, according to the *Financial Chronicle*, are as follows:

	April (125 roads).		Jan. 1 to April 30 (133 roads).	
	1891.	1890.	1891.	1890.
Gross earn..	$52 987,642	$52,9 1,0 6	$205,757,467	$193,551,234
Oper. exp..	37,081,396	37,519,364	141,003,532	142,691,611
Net earn.	$15,906 246	$15,381,672	$59,753,935	$56,859,623

This is an increase in net earnings of 3.41% for April, and of 5.09% for four months. For April the greatest increase is shown by the Northwestern and Southern roads, 15.19% and 26.93% respectively, and for the four months the Pacific, the Southwestern, the Southern and the Coal roads exhibit the largest gains. The earnings as a whole are very favorable considering the general adverse circumstances.

BIDS FOR LIGHTSHIPS are called for by the Lighthouse Board, Washington, D. C. Bids to be opened on June 30. The four ships wanted will be each 113 ft. long, 26 ft. beam and 14 ft. depth of hold. They will be built of iron and have outside bilge keels on each side. Propellers are to be provided so that they can be navigated in case the mooring breaks. Each boat is to have storerooms, cabin, 4 staterooms, coal bunkers, engine- and boiler-room, and crew space with 10 berths, pantry, sailroom, water tanks, chain lockers, etc.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision, June 19, at Sauve, La., on the Illinois Central R. R. A freight train had been backed onto a side track to let an express train pass, but the brakeman forgot to close the switch. The two engines and the mail car were wrecked, the baggage and smoking car and one passenger car derailed, but the vestibuled sleepers were not derailed or injured. Six freight cars were smashed, Four men were killed and six seriously injured. A derailment occurred June 21, near Dover,.O., on the New York, Chicago & St. Louis R. R. The train was an excursion train of 15 cars, and the engine, which was running backward, jumped the track and went down a bank, while 7 cars were derailed. One man was killed and nearly 30 injured. A crossing collision occurred June 19 at Upper Sandusky, O., a Pittsburg, Fort Wayne & Chicago freight train being cut in two by a Columbus, Hocking Valley & Toledo freight train.

BRIDGE ACCIDENTS are reported as follows: On June 18 a highway bridge across Timpis Creek, at Junta, Col., gave way, having been weakened by a flood. One person was drowned and 5 were injured. On June 17 a wooden bridge of 100 ft. span across the Passaic River, near Sterling, N. J., gave way, and a number of persons were thrown into the river, but were all rescued. Bridges on the Lake Erie & Western R. R., between Crandall and Farmdale, Ill., were washed away by a flood on June 17.

THE ST. CLAIR TUNNEL had a cave-in on the Port Huron approach June 16. A considerable portion of the bank gave way, carrying the engine-house with it, but nobody was injured.

A REMARKABLY FAST RUN was made between New York and Buffalo on June 22 by the Chicago Limited of the New York Central & Hudson River R. R. The distance is 440 miles and the running time was 8 hours and 34 minutes or an average running speed of about 51 miles per hour. The train consisted of 7 cars, weighing, exclusive of passengers and baggage, 515,700 lbs., and an engine and tender weighing 201,500 lbs. The train was allowed no special privileges for the run, but took only ordinary schedule chances.

THE ELECTRICAL WELDING PLANT of the Johnson Co., at Johnstown, Pa., is being enlarged. This is already one of the most extensive in the country. The company manufactures street railway rails, and of the five machines now in place one is used for joining rails for switches and crossings, and the others are for large welds of 4-in. and 8-in. sections. The new plant includes five 100 HP. and two 150 HP. Ball engines and a special boiler-house. All of the electrical apparatus used is of the Thomson type.

THE JOHNSTOWN FLOODS have not yet subsided, at least in the courts. Col. W. D. MOORE has commenced suit against the South Fork Fishing and Hunting Club, that owned the dam, for the damages sustained by some of his clients. He charges criminal negligence and says the club membership represents $100,000,000 and is able to pay.

A TORPEDO BOARD of a permanent nature is to be formed by the U. S. Navy Department. It is to have three members and is to be independent of other naval bureaus. This is preparatory to building torpedoes and torpedo-boats on an extended scale, and it is said that 100 Whitehead torpedoes have been already ordered from the English establishment, costing $500,000. Commander GEORGE A. COWES, U. S. N., is already appointed as the first member of the board.

THE CHICAGO DRAINAGE BOARD on June 30 received a report from Chief Engineer S. G. ARTINGSTALL on the continuation of the main drainage channel from Summit to Joliet. The proposed channel is almost entirely artificial, but is located so as to avoid as much as possible expensive limestone excavation. Between Summit and Joliet, a distance of 24½ miles, there will be 21,102,000 cu. yds. of waste material, of which 8,303,385 cu. yds. are rock and the remainder earth. As this is not considered of marketable value, right of way will have to be secured for its deposit. The estimated cost of the work is as follows:

From Summit to west end of 14-ft. channel near Willow Springs.....	$3,907,582
From west end of 14-ft. channel to Lockport....	9,031,973
From Lockport to Joliet....	1,605,910
Total.....	$14,545,465

The cost of right of way is not included in the above.

THE NEW CROTON AQUEDUCT was formally transferred to the Department of Public Works, in its completed portions, on June 24. This is in accordance with the opinion of the Corporation Counsel that the Aqueduct Commissioners have no authority to maintain completed work. The decision involves only the $2-a-day places of the keepers of the gate-houses at Croton Dam, 135th St. and Central Park, and at the blow-offs at Pocantico, South Yonkers and Ardsley.

LITIGATION OVER STEAM CAR-HEATING PATENTS is getting interesting. The Consolidated Car Heating Co. has issued a circular stating that it has recently been awarded the exclusive rights to the use of: (1) a steam coil or drums and a Baker heater in operative contact with a hot water circulating system; (2) an expansion drum with a partition therein; 3) an S-shaped hose connection between cars as used on the Pennsylvania Railroad's return system; (4) the McElroy commingler system or any device by which steam is noiselessly commingled with water in a hot-water circulating system; (5) compromise hose couplers for connecting couplers of different types. The Gold Co. has taken a license from the Consolidated Co. The Consolidated Co. also claims the exclusive right to use the direct system of steam piping commonly known as the Martin system, and has been awarded patents on the construction of a heating drum and a stove and drum combined.

On the other hand, the Safety Car Heating & Lighting Co. claims that the circular issued by its competitor is misleading, in so far as it affects the patents held by the Safety Co. Both these rival concerns agree to protect purchasers of their apparatus from loss through patent suits if allowed the full defense of the case; so the prospective litigation should be no barrier to the progress of steam car heating.

EXPERIMENTS IN PRODUCING AERIAL EXPLOSIONS were made in Washington, June 24, under the auspices of the Agricultural Department. Three balloons each containing about 500 cu. ft. of oxygen and hydrogen mixed in the proportion of 1 to 2, were sent up to a height of 1,000 to 1,200 ft. and exploded by electricity. It is not reported that any rain followed the explosions, and doubtless none was expected from so small an amount of concussion. It may be said incidentally that handling explosive gases is not the safest business known. It is to be hoped that none of the researches undertaken in this apparently quixotic direction will result in vacancies in the Agricultural Department.

THE SUEZ CANAL, in 1890, was traversed by 3,389 vessels, and the total receipts were $13,435,000. The principal work carried on in the year was the widening of the canal, an improvement which it is expected will extend during the present year to a distance of 22 miles from Port Said. The new basin at Port Said has been excavated to its full width for a length of 1,000 ft. The company is building a steam tramway between Port Said and Ismaila, for the transport of goods to the various stations on this 50 miles of canal. The waterway will thus be relieved of the boats and barges now used for this service.

LAKE GENEVA has been sounded lately throughout its whole extent by M. A. DELEBECQUE, and the result of his work is published in the *Annales des Ponts et Chaussees* of March, 1891. Its length on its axis is 44.6 miles and the broadest part is 9.5 miles wide. The greatest depth is 310 m., or 1,017 ft. The average depth of the lake is nearly 500 ft.

Notes on English Railways.

(*Concluded from page 582.*)

NORTH BRITISH RAILWAY.

This is the most extensive of the Scotch railway systems, having a length of 1,247¼ miles. Its connections with English lines are at Carlisle and Berwick. The principal lines run to Edinburgh, Glasgow, Stirling, Perth and to the north along the east coast to Dundee and Montrose, beyond which latter place it has running powers to Aberdeen over the Caledonian Ry. Its Glasgow line passes through the city by the underground City of Glasgow & District Ry. and extends beyond the city to Helensburg, near the mouth of the Clyde. From this point the West Highland Ry., in which the North British Ry. is interested, is being built up through the mountains to Fort William, on the Caledonian Canal. The Queen St. Station, Glasgow, is at the bottom of a steep grade. Trains for that station stop at the summit of the grade and the engines are taken off. One or two brake cars (according to the weight of the train) are attached to the head of the train, which then runs down to the terminus by gravity. The brake cars are short four-wheel platform cars, with squeeze brakes on each wheel, operated by a horizontal hand-wheel.

Track.—The line is laid with bull-head rails carried in cast iron chairs, which are intended to be secured to the ties by 1 spike and 1 trenail on each side of the rail, although in many places only the spikes have been driven. In some places on the line north of Dundee the spikes were either drawing loose or else had not been driven home properly. The chairs are rather narrow, but have the rail seat the full width of the chair, while on some other roads the rail seat is not much wider than the jaw of the chair. The ties are not square, but are sawed only on two sides. The rails are laid with square suspended joints, spliced by plain splice bars and 4 button-head bolts, with the square nuts on the outer side of the rail. The wooden keys are also on the outer side. The ballast is largely of slag, in pieces as large as a man's fist. On some sections smaller ballast is used, or dark gray granite in large, sharp pieces. The ballast is level with the tops of the ties, and in some places a boxing of cinders is placed beyond their ends. Supported joints were seen on some sidetracks, the rail ends being carried in a chair secured to the tie by a spike on each side. The rails are secured in the chair by a wooden key on the inner side, but in the ordinary chairs the keys are on the outer side. The pulleys supporting the signal wires are generally attached to short wooden posts of square section, painted white. This road, however, uses small channel iron posts to some extent, and T irons about 1½ × 1½ ins. near the signal posts. The channel iron posts are shown in Fig. 77. In a cut south of the Forth Bridge a clay pipe drain is laid at the side of the track and covered with ballast. The pipes were about 6 ins. diameter and 3 ft. long, and some of them were very far from being straight. On some bridges across which the ordinary track with crossties and ballast is carried, there is a guard rail of angle iron riveted to brackets on the cross girders, the horizontal leg being uppermost. On another bridge the guard rail consisted of a heavy angle iron with its horizontal leg riveted to the top of the cross girders. A viaduct above Craigo has a ballasted floor, a light parapet and no guard rail. The Dundee station has cemented platforms, with roughened surface, and flagstone coping.

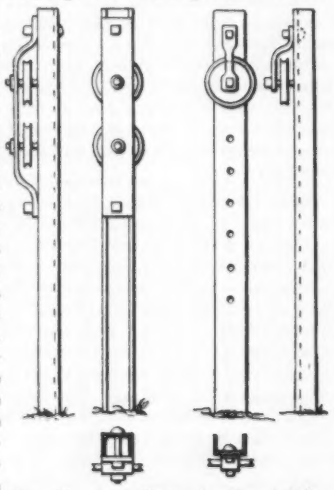


Fig 77. Iron Posts for Signal Wire Pulleys; North British Ry., Scotland.

Locomotives.—Like most of the Scotch railways this road has a number of engines of the eight-wheel type, with inside cylinders. One of these is shown in Fig. 78, and its dimensions are given in the accompanying table. The tender weighs 71,630 lbs. A four-cylinder compound engine of this type was built in 1886 to the designs of Mr. M. HOLMES, Locomotive Superintendent. It had high-pressure cylinders 13 × 24 ins., low-pressure cylinders 20 × 24 ins., and driving wheels 6 ft. 6 ins. diameter. There are also some side tank engines of the eight-wheel type, with solid truck wheels. The tenders have outside frames and bearings on the usual English plan, and some of them have the laminated springs hung below the axle boxes. The Westinghouse [driving-wheel, tender and train brakes are used. The boiler, cab, dome, wheels, splashers and tenders of passenger engines are painted yellow ochre of a greenish shade, with a darker shade of the same color outside the paneling, and with black, cream and red striping. The frames are Indian red, with black and white striping. The appearance of the engines is somewhat similar to that of the engines of the London, Brighton & South Coast Ry. (ENGINEERING NEWS, March 21), but the latter are a brighter ochre. The smokebox and smokestack are black. The freight engines are painted a dark, greenish brown.

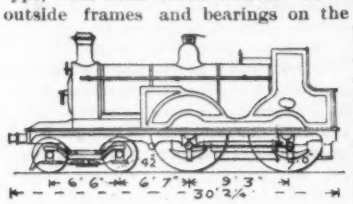


Fig. 78. Eight-Wheel Locomotive; North British Ry., Scotland.

Rolling Stock.—Most of the passenger cars are carried on 4 or 6 wheels with rigid axles. Some old first-class cars with 3 compartments only are still in use. The turtle-back or arched roof is adopted on several of the modern cars. Some of the cars have the exterior finished in the natural wood, varnished, while others are painted a dark plum color. Trains on the Glasgow underground railway are lighted by incandescent electric lamps while in the tunnels, by means of a middle rail charged with electricity from a dynamo at the Queen St. station.

Tay Bridge.—The first Tay bridge was opened in 1878, and a part of it collapsed Dec. 28, 1879, during a violent storm, a train being thrown into the water and 67 persons killed. Plans prepared by Mr. BARLOW for a new bridge were approved by the company in March, 1881, and the new bridge was opened June 14, 1887. It is 10,780 ft. long, with 85 spans of 56 to 245 ft. The navigable channel is crossed by 11 through spans of 245 ft., with a headway of 77 ft. The other spans, 56 to 145 ft., are deck lattice trusses. One end of the bridge is on a curve, and the width of the river at this point is 9,580 ft. Details of the foundations and general construction of the bridge were given in ENGINEERING NEWS Aug. 1, 1885, and Aug. 6, 1887. The piers are of brick and concrete to a height of 8 ft. 6 ins. above high water. Upon the masonry pier are two vertical columns covered with wrought iron plating and united at the top by an arch. The floor is of steel troughs, upon which is laid a double-track line of the usual character, with ties placed rather close together in gravel ballast level with the tops of the ties. Each chair is secured to the tie by 1 spike and 1 trenail on each side of the rail. The rails weigh 84 lbs. per yd., and are laid with square suspended joints spliced with plain splice bars and 4 bolts. Against the girders are laid heavy guard timbers 12 or 18 ins. wide, with an angle iron on the upper corner.

FORTH BRIDGE.

This bridge is owned jointly by the Forth Bridge Co., the North British Ry. Co., the Great Northern Ry. Co., the Northeastern Ry. Co. and the Midland Ry. Co. The four railway companies guarantee the bridge company a dividend of 4%. The railway is operated by the North British Ry. Co. as a part of its system, and this company also attends to the maintenance of track, while the bridge company attends to the maintenance of the structure. Through the courtesy of Sir BENJAMIN BAKER (the active partner of Sir JOHN FOWLER in the design and construction of the bridge) and Mr. ADAM HUNTER, the Resident Engineer, the writer was enabled to examine this great engineering work, but it has been so often and so fully described that no detailed description is needed here. In brief, it consists of 3 double cantilevers, forming 2 channel spans of 1,710 ft. and 2 shore spans of 646 ft. 4 ins. The space between the cantilever arms is 346 ft. 5 ins., and is spanned by lattice girders 350 ft. long and 30 ft. deep at the middle. The clear headway is 150 ft., and the height from the water line to the top of the cantilevers at the highest point, over the piers, is 361 ft. At each end is a viaduct approach of parallel chord deck lattice girders on masonry piers. The girders are continuous over two spans of about 168 ft. each. Between the viaduct approaches and the embankments are masonry arches. The total length of bridge and viaduct is 8,295 ft. 9 ins. The portals at the shore ends of the cantilevers are of masonry of simple design. The bridge carries a double-track railway, and each line of rails is laid in a trough built up of plates and angle irons, forming a guard on each side of each rail, as shown in Fig. 79. The tracks are laid with rails of bridge section, weighing 120 lbs. per yd., and about 28 ft. long. They are secured to teak longitudinals by screw spikes 8 ins. long, which pass through the flanges of the rail. There are 20 of these spikes to each rail, 4 at each end and 12 staggered along the flanges on either side of the head. Spikes 5 ins. long were used at first, but the holes were too large and they began to work loose, so that the 8-in. spikes were being substituted last autumn. The longitudinals are about 12 × 6 ins. in section, and are kept in line by horizontal wedges driven between them and the sides of the troughs, which prevent the use of transverse connections. At joints and some other

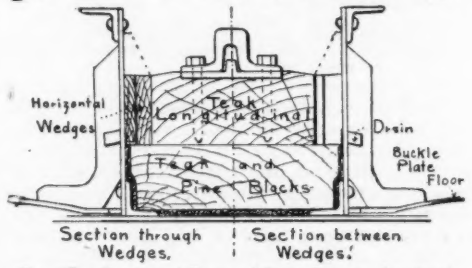


Fig. 79. Track and Floor of Forth Bridge, Scotland.

places a filling of vertical creosoted pine blocks is used, as shown by the dotted lines in Fig. 79, making a good-looking piece of work, and being very safe in case of derailment. It is not to be put in continously, however, partly on account of the cost and partly as it would prevent inspection of parts of the ironwork of the trough. The timbers rest upon a continuous bearing of wooden blocks, with pitch filling. The floor is of buckle plates, with holes to let off the water. There is no ballast. The floor seems to be very rigid, and without sufficient provision for cushioning the vibrations started by trains. The trains make a harsh metallic sound and a jarring in running over the bridge, and this noise and uneasy jarring are unpleasantly noticeable in riding in the cars. The change is very pronounced when the train runs onto the embankment approach, where the track is laid with the same rails on longitudinals, with transoms, in broken stone ballast, the train then riding smoothly and quietly. Along each side of the bridge is an asphalt sidewalk, with a high lattice parapet on the outer side. There are semaphore signals at the entrances and on the bridge. Trains run across without slackening speed. The traffic is said to already exceed the company's expectations, there being 900 trains per week in busy times. The total number from the opening on March 4 to Aug. 25, 1890, was 16,671 trains.

IRISH RAILWAYS.

The time spent by the writer in Ireland was too short to permit of gathering very much detailed information on railway matters. Among the principal systems are the Belfast & Northern Counties Ry., 250 miles; Dublin, Wicklow & Wexford Ry., 143 miles; Great Northern Ry., 487 miles; Great Southern & Western Ry., 522 miles; Midland Great Western Ry., 433 miles, and Waterford & Limerick Ry., 280 miles. A very large proportion of the lines is single track. The standard Irish gage is 5 ft. 3 ins. but there are some short narrow gage railways, mostly operated as light railways or steam tramways, and on some of these lines cars of American type have been tried and found very advantageous

Several extensions and light railways are now under construction, being aided by the Government in order to provide work for the unemployed on account of the great distress in some districts. Flange rails are extensively used, and are secured to cross ties by spikes and bolts. In the west of Ireland is a "single-rail" railway, 10 miles long, built upon the Lartigue system, in which a series of **A** frames supports a single carrying rail on the top and a guide rail on each side. The engines and cars straddle this track. The plan is claimed to be specially adapted for economical construction and light traffic. An important piece of work in progress in Dublin was the construction by the Great Northern Ry. of a line across the city to connect the northern and southern systems and to facilitate the through carriage of mails. It is a very costly and substantial work, built upon property acquired by compulsory purchase in the ordinary way. Through the blocks it is a viaduct of brick and stone arches, and it crosses the streets by plate girder through bridges. The columns in the streets for skew bridges of long span are iron cylinders of large diameter, filled with concrete. The cylinders are fluted and reeded, and have ornamented capitals, giving the columns a massive and handsome appearance. On the Dublin, Wicklow & Wexford Ry. was noticed a curious old second-class open car, a rough sketch of which is shown in Fig. 80. The seats and backs are upholstered in dark leather. Locomotives with 4 coupled driving wheels and a single pair of leading wheels are in very general use, but engines of the eight-wheel type are also used. Side-tank engines of this type are used on some of the light railways. There is a very great deficiency in the continuous brake equipment, the simple vacuum brake being

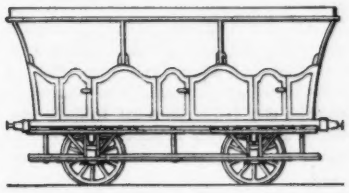


Fig. 80. Old Open Second-Class Car; Dublin, Wicklow & Wexford Ry., Ireland.

the one most used, although the automatic vacuum brake is being more generally applied since the lesson of the disaster at Armagh, on the Great Northern Ry., June 12, 1889.

GREAT SOUTHERN & WESTERN RAILWAY.

This is the longest of the Irish railway systems, having a total length of 522 miles. Its principal lines are from Dublin to Cork and Queenstown, 177¼ miles, and to Waterford, Limerick and Killarney. The company has works at Inchicore, near Dublin, where it builds locomotives and cars.

Locomotives.—Engines of the eight-wheel type are used to haul the mail trains between Dublin and Queenstown, 177¼ miles, in connection with the transatlantic steamers. One of these engines is shown in Fig. 81, and its dimensions are given in the accompanying table. The truck is of the American swing link pattern. The tender weighs 63,392 lbs. loaded. These engines, with a train load of 9 six-wheel passenger cars and a baggage car, about 268,000 lbs., or 420,000 lbs. including engine and tender, make the run in 4 h. 35 m., with 18 m. consumed by stops. This gives an average speed of 42.16 miles per hour, with actual speed of 45 to 60 miles per hour. The coal consumption is 24 to 26 lbs. per mile with this load.

Rolling Stock.—The greater proportion of the passenger rolling stock is carried on 4 or 6 wheels with rigid axles, but there are also cars on four-wheel trucks. Some of these have 2 first-class compartments, with lavatories between them, and 2 second-class compartments at each end. They are 49 ft. long over the buffers, with a body 45 ft. long, 9 ft. wide and 7 ft. high in the middle. The trucks have 4 Mansell wheels 43¼ ins. diameter, with a wheel base of 8 ft. The distance c. to c. of truck pins is 30 ft., and the total wheel base 38 ft. The cars have continuous draw gear, and are fitted with the vacuum automatic brake, having 2 brake shoes to each wheel. The weight empty is about 45,680 lbs. They seat 14 first-class and 40 second-class passengers. Each of the two first-class compartments has a seat for 4 passengers on one side and for 3 on the other side, the vacant space at one side of the car having a door opening into a lavatory which occupies half the width of the car. Each of these compartments, therefore, has separate lavatory accommodation for its 7 passengers, while the 40 second-class passengers have no such accommodation. This very great defect in the design of English cars with some attempt at modern improvements has been already commented upon in the article on the Midland Ry., ENGINEERING NEWS, May 9, 1891. The Smith non-automatic vacuum brake is extensively used, and can be applied by the engine driver but not by the conductor.

	Fig. 78. N. B. Ry.	Fig. 81. G. S. & W. Ry.
Cylinders	18 × 26 ins.	18 × 24 ins.
Diam. truck wheels	3 ft. 6 ins.	3 ft. 0 ins.
" driving "	7 " 0 "	6 " 6 "
" boiler		4 " 3 "
Boiler pressure		150 lbs.
Tubes, No.		204
" diam. (outside)		1¾ ins.
" length	10 ft. 3½ ins.	10 ft. 0⅞ in.
Heating surface: tubes		938 sq. ft.
" " firebox		112 "
" " total		1,050 "
Grate area		18 75 "
Truck-wheel base	6 ft. 6 ins.	5 ft. 3 ins.
Driving "	9 " 3 "	8 " 3 "
Total "	22 " 4 "	20 " 5 "
Weight on truck		30 352 lbs.
" on driving wheels		28,784 "
" on trailing wheels		28,672 "
" total	95,020 lbs.	87,808 "
Tank, U. S. galls.		3,240
Coal		8,960 lbs.

MIDLAND GREAT WESTERN RY.

The main routes of this railway extend across the country from Dublin to Galway and Westport, and it has several other lines in the interior. The total length of the system is 433 miles. The Broadstone terminal station at Dublin is a fine-looking structure

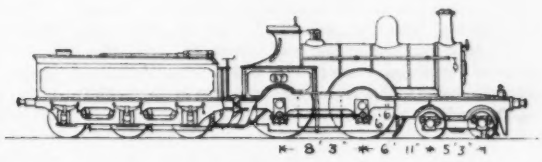


Fig. 81. Eight-Wheel Locomotive; Great Southern & Western Ry., Ireland.

of gray stone, with a colonnade along the outer side of the carriage road which runs parallel with the arrival platform. Mr. J. E. WARD was the General Manager at the time of the writer's visit, but has since resigned.

Locomotives.—The road has about 110 engines, and builds about 6 per year to renew its stock. Their average life is 20 years. The latest passenger engines for heavy trains of 16 or 17 cars have inside cylinders 17 × 24 ins., 4 coupled driving wheels 6 ft. 3 ins. diameter, and a single pair of leading wheels with ¾-in. lateral play in the boxes. They weigh about 87,360 lbs. For the mail trains, which consist of 4 to 6 cars, the older style of engines of the same type are used, with 58-in. driving wheels. The plan of using a single leading axle and providing lateral play in the boxes is found sufficient even for sharp curves. The side-tank engines with 6 wheels, all coupled, weigh 94,080 lbs. equally distributed. About 1885 some side-tank engines were built with 6 coupled wheels, and two rigid axles under a rear tank and bunker. At the Broadstone terminus a saddle tank switch engine is used, which has a single pair of driving wheels, and a single pair of leading and trailing wheels. The cylinders and valve chests are all in one casting, and with the wide gage of 5 ft. 3 ins. there is plenty of room for inside cylinders, with the slide valves between them. The big ends of the connecting rods of the new passenger engines have the caps secured by 2 bolts parallel with the rod. Variable exhaust nozzles are not approved of, and there is a very severe penalty for engine drivers who alter the nozzles. This is based on the fact that the engine is designed for a certain size of nozzle, and the engine driver is not to alter it according to his individual ideas. Equalizing levers are not used, as they are believed to make the engine unsteady on good track and to be only adapted for bad track. This is a very erroneous impression, and the equalizing levers are used on some of the English roads which have the best track. The top of the blast pipe is formed as a hollow ring, perforated with small holes on the inner side and connected with the blower pipe, thus effecting a better distribution of steam for the blower. The firebox and shell are flanged together and riveted at the firedoor opening. A sliding firedoor was used at one time, but was very hot to the men's legs, and has been given up, the door being now hinged at the top. The smokebox tube-plate is carried in a Fox corrugated steel ring, which allows of the free contraction and expansion of the tubes. A screw reversing gear is used. A form of duplex safety valve is used, which

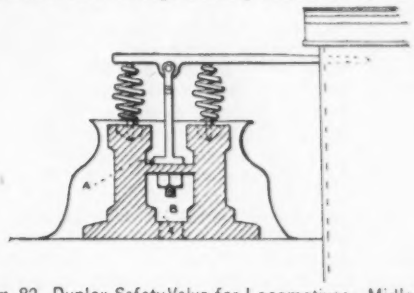


Fig. 82. Duplex Safety Valve for Locomotives; Midland Great Western Ry., Ireland.

was originally designed on this road, and the principle of which is shown in Fig. 82. It differs from the Ramsbottom valve in having a spring to each valve, instead of one spring between the two valves. The springs are carefully adjusted, and can only be altered by putting washers under the foot *A*. This cannot be done without taking off the brass casting and slackening the nut by using a box wrench through the hole *B*, so that the valves cannot be tampered with. Steam driving-wheel and tender brakes are used on the passenger engines, and the vacuum brake on tank engines. At the front of the engines the brake pipe is carried around the front of the smokebox, one leg being fixed and the other turning on a swivel joint at the top of the smokebox. In this joint is a valve which is automatically opened by swinging the movable leg round into the longitudinal axis of the engine in position to couple with the brake pipe of a car, and is closed by swinging the leg back against the smokebox. The engines are painted a light, bright chrome green all over, with black and white striping. The smokebox and smokestack are black, and the dome either of polished brass or painted. Many of the engines have names.

Locomotive Works.—Near the Broadstone terminus in Dublin are the company's locomotive works, which are small but well equipped, and turn out some very nice work. About 6 new engines are built per year. The tools in the machine shop are driven by two compound vertical-wall engines of 60 HP. each, and the machinery in the woodworking shop is driven by an 8 HP. Otto gas engine. Among the special machines are a quadruple boring machine, a planing machine for 20 ft. plates, and an emery grinder for slide bars. This latter machine

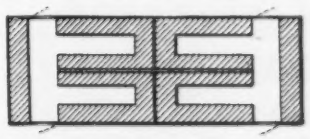


Fig. 83. Arrangement of Seats in Third-Class Car, Midland Great Western Ry., Ireland.

has a traveling emery wheel which moves over a different path at each stroke. It is found very satisfactory, and does its work rapidly. The work of the drawing office is a model of neatness and clearness, there being time in these comparatively small works to devote proper attention to the finish of every drawing and every detail. The drawings are neatly colored, and are filed in shallow drawers for reference. The tracings are very well made. Those for shop use are mounted on linen and fitted on a side-roller or put in a glazed frame in a box on the wall of the shop. Tracing cloth is not so generally used in England as in this country, various qualities of tracing paper being more frequently seen. Mr. ATOCK is Locomotive Superintendent; Mr. ROE, Chief Draftsman, and Mr. HOPKINS, Draftsman.

Rolling Stock.—Passenger and freight cars and horse boxes are built at the company's works, about 12 passenger cars being built per year. The standard passenger cars are 34 ft. long over the buffers,

30 ft. over the body, and are carried on 6 wheels with rigid axles, and a wheel base of 20 ft. Many of the older cars have only 4 wheels. The underframes are of oak. None of the third-class cars have cushioned seats, but the seats are shaped like garden seats. The compartments are wide between partitions. Some of the older third-class cars have the seats arranged on the plan shown in Fig. 83. A six-wheel saloon car was noticed, with glazed ends, drawing room, and the usual arrangement of chairs, lounges and tables. Mansell wheels are very generally used, and are fitted with the Kitson ring, which is a plate on the inside of the disk, used on account of the tendency of the power brakes to shake the wooden filling pieces loose. The simple vacuum brake is used, but is being converted to the system of the Automatic Vacuum Brake Co., which is extensively used on English railways. The exterior of the cars is of a light brown wood, varnished, or is painted a light vandyke brown.

CONCLUSION.

It may be repeated here that these articles have been compiled mainly from notes made on various railway journeys, visits to stations and works, etc., during a long visit to England in 1890. They have been of a rather general character, but giving many details of present practice not found in any other published articles. Detailed information in regard to the track will be found in the writer's paper on "English Railway Track," Transactions Am. Soc. C. E., June, 1888, of which an abstract was given in ENGINEERING NEWS, July 7, 1888. In conclusion, the writer expresses his obligations to many engineers and other railway officials for courtesies extended and facilities given for visits to works, etc.

E. E. R. T.

Increased Water Supply for Golden, Colo.

We are indebted to Mr. D. C. HENNY, C. E., Denver, Colo., for the following description and the accompanying illustrations:

The water supply of Golden, Col., has for years back been insufficient. Originally it was taken from a stone well, 25 × 72 ft., 20 ft. deep, sunk in the Clear Creek valley, about ¾ miles below the cañon. The well is located 200 ft. north of the creek, at the foot of the sidehill, the valley at that point being 500 ft. wide. The material in which the well is sunk is a mixture of sand, gravel and boulders, which is rather tight, causing the area affected and consequently the yield, to be small, about 100,000 galls. daily, which for a town of 1,500 inhabitants is entirely adequate during the dry summer season. Various expedients have been resorted to to increase the supply, all of which will be better understood by referring to the accompanying plan and profile. Water was let into the well from a mill ditch running along the sidehill above the pumphouse, first through a wooden filter-box, afterward through filtration from ponds around the well, both, however, with unsatisfactory results, owing to the large proportion of mine tailings carried by Clear Creek, from which the water in the mill ditch was taken. Another well was afterward sunk. This well was 30 ft. deep, and was located below the pumphouse. A pump was placed in the well, and thus some 100,000 galls. were added to the daily supply. This left the supply still insufficient, necessitating at times the admission of ditch water into the large well without any filtration.

A plan to construct a line of gallery pipe was proposed and executed last spring. From the well a wooden box flume, 10 × 10 ins. inside and 350 ft. long, leads up the valley on a flat grade. The flume terminates in a manhole, into which a line of 24-in. cement pipe, 565 ft. long, discharges. This cement pipe is laid with open joints on a track of two 2 × 4. in. stringers connected by crosspieces, and at a depth of from 9 to 12 ft. below the surface and from 8 to 11 ft. below the original level of the ground water. Coarse, clean gravel was put all around the pipe, and the balance of the trench was filled with the ordinary material. There are besides the lower manhole two more manholes, in the tight wooden bottom of which a round hole was cut, through which a piece of pipe was sunk, allowing the water to come up. The direction of the line of gallery is up stream, making an angle of about 40° with the general direction of the valley, and approaching the opposite bank. The total joint opening is about 21.5 sq. ft., and the yield is 350,000 galls. daily, making the average velocity of entrance through the joints $\frac{3}{10}$ cu. ins. per second. The area of water-bearing gravel above the gallery is about 20 acres, feathering out at the upper end in the cañon. The total cost of this improvement was nearly $3,000. The water is perfectly clear and soft and is kept away from the light, the pump-well being covered over. A great advantage of this gallery in connection with the direct-pumping system is that it creates a storage reservoir in the gravel when the amount of water pumped is less than the yield.

About two weeks after completion the street mains were flushed out, for the first time in many years. During an entire day three hydrants were kept open and the 1,500,000-gall. pump run to its full capacity. In the evening the water in the well was found to have been lowered but 14 ins.

The Grand Avenue Bridge, St. Louis, Mo.

(WITH INSET.)

The general view of the Grand Avenue Bridge, lately built for the city of St. Louis, and given in the inset with our present issue, is a most happy illustration of what can be done in making a steel and iron bridge pleasing to the eye architecturally, as well as simply useful to the citizens. The designer and engineer is Mr. CARL GAYLER, bridge engineer for the city, and it was constructed and built by the King Iron Bridge & Manufacturing Co., of Cleveland, O.

This bridge carries Grand Ave., a prominent thoroughfare, over the railway tracks in Mill Creek Valley. The avenue itself commences near the present water-works, and extends south for a length of over 13 miles. It connects the fair grounds and Zoological Garden in North St. Louis, with Tower Grove Park and Carondelet Park, and is, consequently, so largely used as a drive that the city authorities felt justified in building upon it a viaduct of a more expensive character than those previously used in that city.

The track systems of the various railways entering the city from the west are steadily increasing, and it was deemed advisable to use spans of considerable length, with substantial stone piers. The railways now coming into the city from the west include the Missouri Pacific, Wabash, Iron Mountain & Southern and the Atchison, Topeka & Santa Fé, and more may follow at any time.

The system used is novel, the accompanying diagrams showing it to be a three-hinged inverted

PROFILE AND PLAN OF NEW UNDERFLOW WATER SUPPLY; GOLDEN, COL.

arch with the thrust resisted by trusses at each side, which are also hinged at their ends so as to avoid any ambiguity in the distribution of stresses throughout the structure. The Point B idge, in Pittsburg, Pa., built from the plans of Mr. EDWARD HEMBERLE, in 1875, and the type of bridge known as the Claxton-Fidler straight-link, stiffened suspension bridge, are similar to the Grand Avenue, as seen in Figs. 2 and 3

Fig. 1.

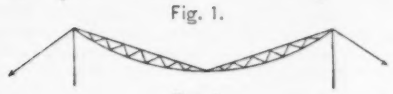


Fig. 2.

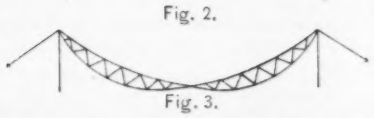


Fig. 3.

on the diagram. But in place of the unsightly stiffening trusses, which impair the fine effect of the suspended cables, this bridge has its stiffening system put underneath, with chords parallel to the cables.

The anchorages, which we will show in another issue along with other detail, present some novel features not before introduced into suspension bridges in this country. They are accessible, and allow free expansion of the members inside the anchorage pier.

The material used in the bridge was mild steel for the main trusses and tower, and wrought iron for the floor system and wind trusses. The length of the bridge, including approaches, is 1,600 ft., with 400 ft. between centers of the towers and two end spans of 150 ft. each. The clear width of the roadway is 36 ft. and 42 ft., with 60 ft. over all. The bridge is paved with a white pine block paving. The total cost was $450,000.

We are indebted to Mr. Frank C. Osborn, Chief Engineer of the King Bridge Company, for the excellent photograph from which our inset is made.

Notes on the Nicaragua Canal.

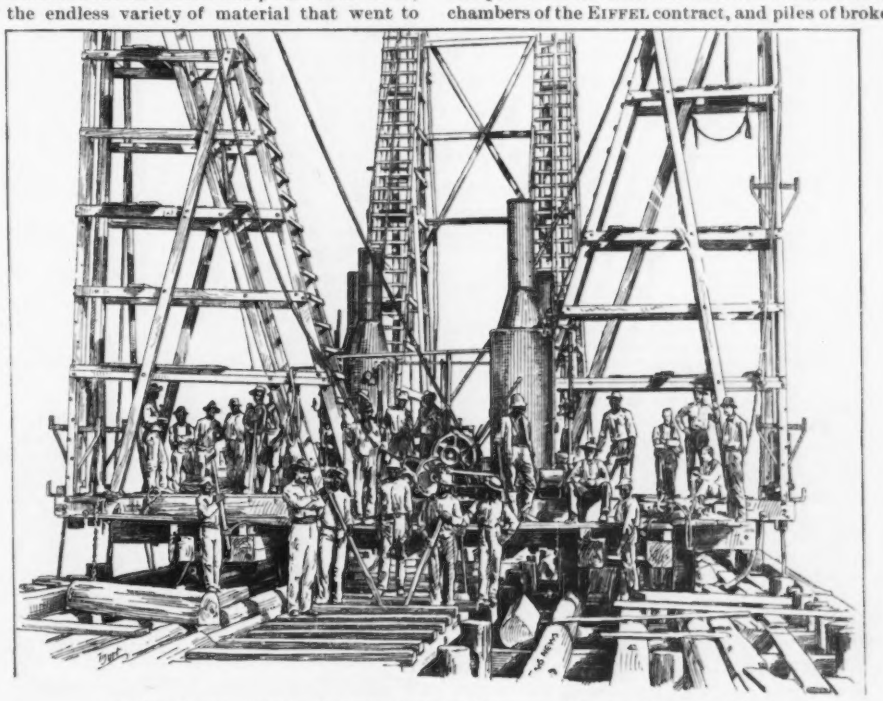
(*Concluded from page 579.*)

Our notes on this journey over the route of the Nicaragua Canal would hardly be complete without some record of the impressions left of a trip by rail alongside its older but now very decrepit brother at Panama. The bulk of our observations were made from the rear platform of a rapidly moving train; but we had as our Mentor Mr. LEFEVRE, the General Agent of the Pacific Mail Steamship Company, a man who has spent years upon the Isthmus and was familiar with every foot of the way.

The first signs of the artistic work and extravagance of the French canal-builders were met with in coming into Panama Bay, past the famed Sanitarium of Toboga. There a city of hospitals has been built, with bright red tiled roofs and massive retaining walls peeping out of park-like grounds threaded with walks and drives for the Director-General and his subordinates. A costly roadway connects this sanitarium with Panama. As the latter city is approached, another hospital, or a mass of hospital buildings, looms in sight, situated on the high ground back of the town, and built and adorned even more elaborately than those at Toboga. We had no time to visit them, but the surgeon of our vessel said that they vied in their appointments with the best hospitals in France, excepting only in the one essential of proper drainage. By an oversight of the engineers they were located on this hill, planned and constructed before any arrangement had been made for carrying the sewage through the city of Panama, which lies between the hospitals and the bay. When this time came, the citizens, who seem to believe in keeping their own sewage within the city limits, grew virtuously indignant at the proposition of the hospital authorities to carry the sewage through the town; and they had goodly reason. The tide at Panama is over 20 ft., and when this goes out it leaves exposed broad flats of mud that now cry out to the high heavens in their foulness. It is possible that the hospital sewage might have added another variety of evils to those existing, but it is hard to realize that this could be.

Panama itself could discount in variety and density the famed smells of ancient Cologne. In passing through the streets these assail you from open gutters and narrow passageways between the houses; you come upon them at times so suddenly and the effect is so overpowering that the term solid can alone express their individual intensity. But men seem to grow accustomed even to foulness like this; and in the private office of one of the chief bankers of the city, we found an atmosphere, due to faulty sanitary arrangements, that ought to have bred fever and disease, if it did not. Panama is dull, its hotels are empty, and its business men sigh for a return of the glorious days when the town was alive with those who grew fat upon the plunder from the canal and came here to get rid of some of their surplus gains.

Almost immediately upon leaving the city on the Panama Railroad you come in sight of the canal works. The towers of Belgian and French dredges appear above the trees in now detached and partly filled-up channels, that were once sections of the sea-level canal. A little further east, and you come to an almost continuous line of villages for laborers that were never occupied, storehouses, sidings filled literally with miles of dump-cars, locomotives and other machinery, past stacks of Decauville railway track and the small iron dump cars to fit them, and the endless variety of material that went to



Jet Pile Drivers Used in Building Jetty at Greytown Harbor; Nicaragua Canal.

make up the plant of the most extravagantly equipped public work the world ever saw. Near Tavernilla we saw a line of steam cranes, almost buried in the jungle, that we have undoubted authority for saying have occupied this same siding for years—they were never used. On another siding we saw about 60 clumsy locomotive-boiler steam-drilling machines, with the drill-frames rigidly attached alongside the boiler. These too had been there for years, and had never been fired up, for the proper reason that they were utterly worthless for work on the Panama Canal.

All of the machinery in sight was well cared for, and outwardly looked well enough with black paint and white-leaded bright work. They had been put in this condition just previous to the visit of the last French Commission, and it is said that $20,000 per month is now being spent in keeping them in a presentable shape. Yet a mechanical engineer, who examined some of this machinery with a view of possible purchase, informed us that when he attempted to open the doors to look into a boiler, these fell off, a thin shell of rust covered with paint. Inside, the boiler was so scaled with rust that he thought that a good blow with the fist would have punched a hole through the plates almost anywhere. When Mr. LEFEVRE was asked why this plant was not gathered up and shipped out of this moist, iron-destroying climate, the reply was that we evidently knew little of Panama railway freight rates. The transportation charges would have eaten up all the profits, even if the machinery were bought at old-iron prices.

The buildings along the line of the canal number thousands, though comparatively few seem to have been occupied. These houses are constructed of wood, with corrugated iron roofs; but cheap as some of them looked otherwise, they were generally propped up on pillars of stone masonry laid in cement mortar, that cost more money at times than the building they supported. The story goes that these buildings were erected by the contractors at the canal company's expense, and that the builder recived 20% of their cost for his trouble. As this percentage was a good enough profit for the average man, it is only natural that veritable towns were built whenever the opportunity was presented. The same story is told in explanation of the vast amount of unused machinery on hand; and that some arrangement of this kind did exist there is little doubt, from other than hearsay evidence.

On the line of the canal a large amount of work has undoubtedly been done, and some of the cuts are deep and wide and the spoil banks are high. But it is just as evident that an immense amount of work yet remains to be done before even a lock canal can be built. As to these locks, we saw in several places considerable excavation made for the lock chambers of the EIFFEL contract, and piles of broken stone for concrete and sections of the iron lock gates were on the ground. As the Chagres is approached, coming from the west, it is possible to estimate its capacity for mischief to the completed canal by the damage done to the present works and the flood marks along the railway. Parts of the canal once excavated at great cost are almost completely filled up again, and in other places the banks have washed in and the channel is obstructed. Nearer Colon, channels that once admitted vessels of 14 ft. draft 14 or 15 miles inland are so blocked up in places that a canoe alone, could navigate them. On the eastern or swampy side there is a decided and apparent difference in the soil that required dredging, as compared with the east end of the Nicaragua Canal. Here it appears to be a quagmire of unknown depth, and it is little wonder that the deposit from the conveyor pipes of the dredges forced up the soil in the line of the canal being excavated. Night approaching and a steamer awaiting our arrival prevented any inspection of the canal works at Colon, much to our regret. But we saw enough to appreciate the dimensions of the task undertaken, in the wharves, cranes, warehouses, etc., near our ship, and the present size of the town, for which dry land had first to be created. In a word, the Panama Canal, in its length, is to-day a magnificent ruin; but is also a telling monument to the extravagance and bad management of its promoters.

As correcting our data of Sept. 14, 1889, to the present date, we give in a semi-tabular form the revised distances, etc., and the estimate of quantities

for the several divisions and different classes of work. We purposely omit item prices, leaving these to be affixed as personal examination and the study of controlling conditions may dictate. But we do give separately the prices of the more important items as used by the estimating engineer, with some comment upon them.

DIMENSIONS OF THE SEVERAL SECTIONS OF THE PROPOSED CANAL.

SECTION OF CANAL.	Length miles.	Top width, feet.	Bot. width, feet.	Depth, feet.	Area of prism, sq. ft.
Greytown to Lock 1	9.297	288	120	28	5,712
Lock 1 to Lock 2—Canal.	1.258	210	120	30	4,950
Lock 2 to Lock 3—Canal.	1.680	210	120	30	4,950
Lock 2 to Lock 3—Basin.	1.762	.....	.....	30	.....
Lock 3 to West End Divide cut, canal	2.917	80	80	30	2,400
Lock 3 to West End Divide cut, Deseado Basin	3.086	.....	.....	45	.....
West End Divide cut to Ochoa, canal	1.233	184	80	30	3,673
West End Divide cut to Ochoa, San Francisco Basin	11.267	.....	.....	40	.....
River San Juan to Toro Rapids	37.040	.....	.....	52	.....
River San Juan, where dredged	27.500	.....	125	28	.....
Lake Nicaragua	55.560	.....	150	50	.....
Lake to Divide cut, canal	1.565	210	120	30	4,950
West Divide cut, canal	4.924	80	80	30	2,400
Divide cut to east end Tola Basin	2.519	184	80	30	3,673
East End Tola Basin to Lock 4	5.504	.....	.....	50	.....
Lock 5 to Lock 6, canal	1.582	184	80	30	3,673
Lock 6 to Brito Harbor, canal	0.570	288	120	28	5,712

RECAPITULATION.

	Miles.	Total length. miles.
Canal excavation, east side	14.870	
" " west "	11.160	
Lock " both "	.759	26.789
Deseado basins	4.848	
San Francisco basins	11.267	
Tola Basin	5.504	21.619
River San Juan	61.540	
Lake Nicaragua	56.500	121.040
From Atlantic to Pacific		169.448

GENERAL CANAL DATA.

Total length, ocean to ocean	169.448 miles
Length of natural waterway	121.040 "
Length of excavated canal	26.789 "
Length of artificial basins	21.619 "
Length of summit level	153.250 "
Maximum cut, Atlantic side (to water level)	298 ft
" " Pacific side " "	42 "
Width of excavated canal at top	80 to 288 "
" " at bottom	80 to 150 "
Depth of excavated canal	28 to 30 "
Dimensions of lock chambers	650 by 70 "
Lock No. 1. 30 ft. lift; 9.3 miles from Atlantic.	
" No. 2. 31 ft. " 11.0 " " "	
" No. 3. 45 ft. " 13.1 " " "	
" No. 4. 42½ ft. " 2.2 " " Pacific.	
" No. 5. 42½ ft. " 2.2 " " "	
" No. 6. 21-29 ft." 0.6 " " "	
Summit level above mean tide in Pacific	110 ft.
Range of tide on Atlantic side	1.5 to 2 "
" " Pacific "	8 "

PROBABLE QUANTITIES.

EASTERN DIVISION (18.864 MILES), FROM GREYTOWN TO EAST END OF SAN FRANCISCO BASIN.

Section 1.—Greytown to the Divide (15.947 miles).

Earth excavation above water	1,819,820 cu. yds.
Dredging	13,547,597 "
Stone pitching, sides of canal	172,288 "
Grubbing and clearing	925 acres
Lighting canal at half-mile intervals, 24 incandescent electric beacons and plant.	
Lighting locks, 30 electric arc lights and separate dynamos for each lock.	

Section 2.—The Divide (2.917 miles).

Rock excavation	7,000,230 cu. yds.
Earth "	3,034,904 "
Grubbing and clearing	169 acres
Lighting canal—6 incandescent beacons, etc.	
Narrow section of canal to receive double fender wales on each side	11,600 lin. ft.

Railroads and telegraph.

Railroad, from Lock 1 to San Francisco Basin	12 miles
Telegraph, Greytown to San Francisco Basin	22 miles

Locks on Atlantic side.

No. 1. Earth excavation	463,603 cu. yds
Concrete work	120,044 "
Stone pitching in basin	2,400 "
Fender wales	3,699 cu. ft.
Fender piles, 45 ft. long	1020 "
Gates, machinery, building, pumps.	
No. 2. Earth excavation	308,918 cu. yds.
Concrete work	120,430 "
Stone pitching	2,400 "
Fender wales	3,699 cu. ft.
Fender piles, 45 ft. long	1,020
Gates, machinery, buildings.	
No. 3. Earth excavation	528,673 cu. yds.
Concrete work	147,627 "
Fender cribs	32
Gates, machinery, buildings.	

Harbor at Greytown.

Brush and pile pier, length	900 ft.
Stone in breakwater (extension of pier).	225,907 cu. yds.
Dredging in sand	9,550,000 "
Lighthouse, buoys, etc.	

Auxiliary Work, Eastern Division.

Diversion of Deseado, dredging in sand and earth	105,500 cu. yds.
Rock fill embankments, Valley of Deseado	210,625 "
Earth in embankments	836,329 "
Surface soil excavated	79,658 "
8-in. sheet piling, 30 ft. long	5,100 lin. ft.
Wales and guides	250,000 ft. B. M.
Trestles for dumping stone, etc	2,500 lin. ft.

SAN FRANCISCO DIVISION (12.50 MILES).

FROM WEST END OF DIVIDE CUT TO SAN JUAN RIVER.

Clearing trees from line	725 acres
Rock excavation	30,309 cu. yds.
Earth excavation	2,698,195 "
Incandescent beacons and plant	24
Guard gate or movable dam at the San Juan River	15 miles
Telegraph from Divide to Castillo	40 "

Auxiliary Work, San Francisco Division.

Earth embankments	3,239,705 cu. yds.
Rock fill "	1,575,459 "
Surface soil excavated	192,415 "
8-in. sheet piling 40 ft. long	12,600 lin. ft.
Guide piles, 30 ft. long	1,458
Wales and guides	524,000 ft. B. M.
Trestles for dumping	27,5.5 lin. ft.
Grubbing and clearing for dams	175 acres

LAKE AND RIVER DIVISION (121 MILES).

FROM OCHOA TO THE WEST SHORE OF LAKE NICARAGUA.

Ochoa Dam at San Juan River.

Earth excavation	18,500 cu. yds.
Concrete core wall	1,550 "
Bearing piles for trestles, 45 ft. long	830
8-in. sheet piling, 30 ft. long	2,330 lin. ft.
Trestles, guides, etc	1,180,000 ft. B. M.
Rock filling in dam	807,020 cu. yds.
Earth "	629,090 "

San Juan River (64.5 miles).

Rock excavation under water	398,613 cu. yds.
Earth " above "	422,540 "
Dredging in earth	2,150,900 "
Grubbing and clearing across bends	377 acres
Lights, buoys, river beacons, etc.	
Telegraph	70 miles

Lake Nicaragua (56.5 miles).

Rock excavation under water	176,732 cu. yds.
Dredging	4,726,076 "
Lights, buoys, etc.	

Auxiliary work, Lake and River Division.

Earth embankment, San Carlos ridge line	293,240 cu. yds.
Surface soil excavated	22,375 "
8-in. sheet piling, 40 ft. long	450 lin. ft.
Guide piles, 30 ft. long	45
Wales and guides	18,000 ft. B. M.
Grubbing and clearing	3½ acres

WESTERN DIVISION (17.04 MILES).

FROM LAKE NICARAGUA TO BRITO HARBOR.

Rock excavation above water	5,696,507 cu. yds.
Earth " " "	5,399,316 "
Dredging in sand	1,066,666 "
Stone pitching, sides of canal	20,753 "
Grubbing and clearing	1,035 acres
Lights, beacons, buoys, etc.	
Narrow gage railway	18 miles
Telegraph	18 "

Diversion of Rio Lajas into the Lake.

Rock excavation	249,508 cu. yds.
Earth "	164,786 "

La Flor Dam.

Grubbing and clearing	17 acres
Surface soil excavation	320,000 cu. yds.
8-in. sheet piling, 50 ft. long	3,320 lin. ft.
Bearing piles	322
Wales and guides	50,000 ft. B. M.
Trestles for dumping	1,600 lin. ft.
Earth from canal excavation	918,000 cu. yds.
Rock from lock excavation	830,000 "

Locks.

Nos 4 and 5.	Rock excavation	664,194 cu. yds.
	Earth "	127,646 "
	Concentre work	100,000 "
	Fender piles	1,020
	Fender wales	3,699 cu. ft.
	Stone pitching in basin	2,400 cu. yds.
	Gates, machinery, buildings.	
No. 6.	Rock excavation	61,698 cu. yds.
	Earth "	124,800 "
	Concrete work	126,000 "
	Fender piles	1,020
	Fender wales	3,699 cu. ft.
	Stone pitching	2,400 cu. yds.
	Gates, machinery, buildings, pumps.	

Brito Harbor.

Dredging	5 658,898 cu. yds.
Stone in breakwaters	383,899 "
Lights, buoys, etc.	

Other Auxiliary Work.

Guard gate or movable dam at divide.	
Crib piers at lake entrance to canal.	
3 swinging bridges over canal.	
Embankment near site of locks	189,016 cu. yds.
Masonry walls at head of lock 4	19,080 "

RECAPITULATION OF QUANTITIES.

Rock excavation above water	13,617,724 cu. yds.
" " under water	575,445 "
Earth excavation	21,569,764 "
Dredging, earth and sand	31 146,739 "
Total earth and rock excavation	66,909,672 cu. yds.
Stone pitching	202 641 "
Concrete in locks, etc	615,651 "
Stone in breakwater	609,806 "
Rock-fill in dams	3,424,004 "
Earth embankment in dams	6,105,380 "
Masonry at lock No 4	19,080 "
Sheet piling, 8 in	25,000 lin. ft.
Cross-ties and guides for sheet piling	2,022,000 ft. B. M
Grubbing and clearing	3,427 acres
Telegraph line	150 miles
Railroads	45 "
Trestles for construction	31,685 lin. ft.
Lights, buoys, gates, buildings, etc.	

The above detailed statement and the recapitulation will give a very good idea of the location and character of the various classes of work and the total amounts to be handled. We have added no item prices, but can state that the grand total of the estimate of the cost of doing this work, and including surveys, hospitals, shops, management and contingencies, is set down at $65,084,176.00. We have seen a list of the item prices used in making this estimate; and after looking over the ground we believe that they fairly represent the cost of doing work in this region, assuming that there is abundant capital on hand to properly equip the line of the canal for efficient and continuous work, and that contractors are paid in cash. The chief item prices are identical with those published in our issue of Sept. 14, 1889; but to unite them with the present and revised statement of quantities we repeat them as follows:

Earth excavation, per cu. yd	$0.40
Earth and sand dredging, per cu. yd	$0.20 to 0.30
Rock excavation, per cu. yd	1.50
Rock under water per cu. yd	5.00
Stone pitching, rock furnished, per cu. yd	2.00
Concrete work in locks, per cu. yd	6.00
Stone in breakwaters, from divide cuts, per cu. yd	1.50
Borrowed earth embankments, per cu. yd	0.70
Earth embankment from cuts	0.25
Rock for dams, from cuts	$0.40 to 0.50
Grubbing and clearing, per acre	100.00
Sheet piling in place, per M. B. M	675.00
Lumber for guides and wales, per M. B. M	50.00

Sections and Mechanical Conditions of Car Wheels.*

It is strange that the mechanical conditions under which car wheels are used have received so little attention from engineers and railway men generally when the great attention given permanent way is considered, and almost equal attention has been given to the equipment. Between the two comes the car wheel, which must receive and transfer all of the load and power, enables motion, and supplies through mechanism operating upon it the only means of control over the enormous forces developed and used. What engineer can describe the section of car wheel best adapted to safety? (I am speaking of chilled wheels; the kind that is under 90% of the equipment in this country.) Who can say from actual knowledge how much the wheels under the cars of his company vary in diameter from each other on an average; or how much they are out of round or out of balance, or whether wheels of the same weight are placed on each axle? Considered as a whole, good management in practical matters of the kind will embrace all conditions affecting every branch; if one is neglected, the results that might be obtained from the others are lost. Therefore, the subject is one in which a proper interest may be taken by all concerned in the construction, maintenance or operation of railways. As stated, 90% of the equipment of the country has chilled car wheels under it, and therefore the subject is determined mainly by wheels of that class.

I will present the matter under two heads: First, Proper section and methods of manufacture; Second, Mechanical defects, their causes and results.

The best section of wheel depends largely on the service intended and upon the quality and character of the wheel, but certain lines should be followed irrespective of these two conditions on all steam roads. The strains imposed on a wheel are of two kinds: the first consequent on load carried and speed attained; the second, that which results from the use of brakes. The first strain multiplies the second in a definite degree. Given a speed of 20 miles per hour with a load of 5 tons per wheel, and a pressure of 50 lbs. in a 10-in. Westinghouse cylinder giving 10,000 lbs. pressure on each brake shoe. This pressure applied for 5 minutes under the conditions named will develop through friction a certain amount of heat; the wheel must take up the heat and consequently expand. Just what strain is developed in the wheel during the operation is not easily determined, but it is over 100 tons. On heavy grades it is common practice to carry double the load named, at double the speed and with double the continuous brake application; presumably each condition would double the strain. The last one, *i. e.*, heat developed by friction, would increase it in a greater ratio because it would be a continually increasing condition.

In other construction strains are provided for that are beyond anything met with in service. The same must be done in a car wheel if absolute safety is sought. There have been more people killed and property destroyed with broken wheels than by defective bridges.

The New York Car Wheel Works' standard section car wheel is the regular double-plate style of wheel, known as the "Washburn" pattern. The section lines and curves,

[* Abstract of a paper by Mr. P. H. GRIFFIN, Assoc. Am. Soc. C. E., read May 25 at the Annual Convention of the American Society of Civil Engineers].

however, are peculiar to the standard named, and are based upon practical, and extended experience as well as upon long continued and elaborate investigations. A 33-in. wheel of this section, with 5/8-in. plates and of standard hub, bracket and tread dimensions, weighs 550 lbs. Wheels are made to this standard in all diameters from 24 to 48 ins., and weighing 400 to 1,200 lbs. The hub section is calculated to stand a strain of 150 tons in pressing on axle; this is more than double the pressure used. Wheels of heavier section are made to higher standards in this respect, the limit going up to 500 tons. The core dividing the double plate is made, as shown in Fig. 1, with a slight lip on the outer edge. It is common practice to bring the lines of the core at this point to an abrupt finish, with the idea of making the metal at the junction of the plates heavier, and therefore presumably stronger. As a matter of fact, the opposite result is produced when this is done, for the greater body of metal remains fluid and soft a little longer at that point, and therefore the shrinkage of surrounding parts is fed from it, leaving the metal porous and weak at the very place where it should have the most strength. To this cause is largely due the fine cracks found at the junction of the plates when wheels are subjected to continuous heat service. These cracks do not always go through the plates, often do not penetrate over 1/4-in., but they form starting points for more serious defects. The core dividing the two plates is known as a "pan-core," because it is made in a dish or core-pan formed to the shape of the bottom of the core; the top is made with an iron sweep pivoted on a center hub in the core-pan. In Fig. 2 *A* is the pan, *B* the hub, *C* the sweep; *D* indicates a ring set in the core-pan

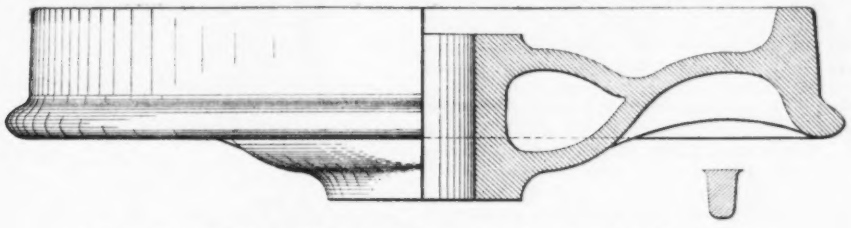


Fig. 1. Standard 33-in., 600-lb. Car Wheel of the New York Car Wheel Works.

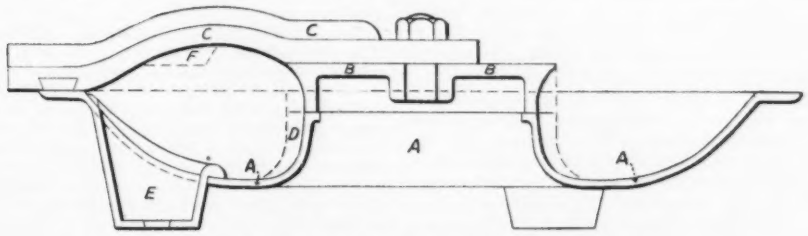


Fig. 2. Standard 33-in. Core Pan, with Hub and Sweep.

and used with a larger hub to give extra metal when a larger size core is wanted in the wheel. The use of these rings is very necessary; otherwise wheels are bored out for large axles with the consequence of leaving insufficient metal in the hub to withstand the strain. There should never be less than 7/8-in. of metal in the wheel hub at the center of wheel seat—the thinnest point, after it is bored for the axle. The core is sustained in position on the mold by the legs *E* fitting into depressions in the wheel mold made by prints on the pattern. *F* is a depression in the top of the core to receive the end of the chaplet which keeps the core in position. Cores are frequently used without this last provision, but it is very necessary, as it provides an extra quantity of metal in the form of a boss on the inside plate of the wheel, at a point where the iron chaplet is very liable to cool the hot metal quickly, and chill it for a space of 1/2 in. or more around the chaplet, thus providing a starting point for defects. A great deal depends on the use of perfect pan cores and upon the exercise of great care in every detail concerning them. When the best attention is not given, internal defects result in the wheel, very difficult to detect. If the chaplets are not exactly and firmly adjusted, one plate will be thinner than the other, and the metal consequently harder and weaker.

The bracket is 1 1/4 ins. thick at center and 2 ins. deep. It fulfills two functions: the first to act as a runner or gate for the molten metal flowing into the tread, and the second to afford strength and support to the tread and flange in service. The section should therefore be determined by the area necessary to admit of the hot metal passing freely and rapidly to the flange and tread, and also by the dimensions best calculated to meet the expansion and contraction resulting from brake service. The bracket is curved to the radius of 5 3/4 ins. inside and 6 7/8 ins. outside. As the hot metal is poured into the mold, brackets o this shape allow it to pass to the tread of the wheel with the least possible strain upon the casting, at a time when it has little or no practical consistency. It is vitally important that the metal be poured into the mold quickly and as hot and fluid as possible, to insure homogeneity and soundness in the casting. In regular practice the metal should be cast into a 600-lb. wheel in 12 seconds. It takes with runners, head, screws, etc., over 650 lbs. of metal to cast a wheel of this weight, and things have to be pretty nicely and perfectly adjusted to admit this rapid casting, and the circular bracket is one of the most important features in making it possible. The style of bracket generally in use is the ogee, or double curve. Presumably this style gives a better support to the tread, running at right angles to it. In practice, however, it is objectionable, for two reasons: First, In casting the metal forming the tread flows through the brackets and strikes the cold chill forming the tread surface at a right angle, and must separate and pass to the right and left with many particles partially chilled, and with no chance for them to remelt and become homogeneous with the balance of the casting It is almost impossible to pour metal as rapidly or as hot through brackets of this kind as through the single curved ones, because of the strain upon the casting when the mold is filling. With the single curved bracket the pressure on the mold is not direct on its exterior; it is lateral all around. Second, In service when the brakes are applied and the wheel expanded the single curved bracket will adjust itself to the expansion and contraction better than the double-curved bracket, and prevent what is known as "cracked brackets."

The tread section has been considered by some too light, probably because of comparison with other patterns having heavy section at this point, to give an apparent solidity to the wheel. The uniform distribution of metal in the wheel is all important, and no greater mistake can be made than to add to parts which can be judged as to thickness and weight, at the sacrifice of parts the section of which cannot readily be ascertained. It is all important that the part of the wheel directly under the action of the brake-shoe be not of extra thickness at the sacrifice of metal in the plates and brackets. All the strain is thrown on the latter, and the greater the bulk of metal heated in the tread the more liable the wheel is to crack and break. Due consideration should be given these facts, and proportions followed that will provide against danger from every source.

The point of junction of single plate to tread is very important, chiefly on account of effect of expansion from brake service. The contact of the brake-shoe is necessarily with the flat surface of the tread, and the metal in the flange acts as a preventive against expansion. When the single plate joins the tread too near the top of the latter it forms, in connection with the flange and brackets, a complete resistance to the expansion of the wheel. If it is kept lower down, when the tread is heated the top portion can expand, and the whole casting can, if properly constructed, give a little without fracture; but when, as is sometimes done, the single plate is brought up near the top of the tread, there is complete resistance at every point. The single plate is sometimes brought near the top of the tread to prevent the latter "chipping" or breaking out, but trouble of this kind does not occur if wheels are properly and carefully made, and the practice is dangerous for the reasons stated.

Any style of chilled wheel can be tested for capacity to stand expansion from brake service by the following simple means: Lay it horizontally on the foundry floor; provide a sectional pattern that will allow sand to be molded around the wheel and leave an opening 1/2 in. wide all around, extending from the throat to the edge of the tread. This may be quickly filled with molten iron from several small ladles, and the result is a band of hot metal 1/2-in. thick and 4 ins. wide, cast around the wheel. The effect is the same as that produced by a sudden and severe application of brakes. If properly constructed, the wheel should not crack in the plates with the application of the sett. It causes a series of fine vertical cracks around the wheel and renders it unfit for service, but it may be used with entire satisfaction as to the value of results on wheels condemned for slight foundry defects.

A pattern of proper section is the first necessity; the second is the method by which the wheels are made. The manufacture is hard, laborious work. A first-class molder, if given a car wheel to make with ordinary foundry tools and appliances, would make possibly one or two for a day's work, and consider it a big day's work at that. Special tools and appliances are provided for the business, however, and one man with a helper will turn out, on the average, 18 wheels per day. The work is done almost invariably by the piece, and is commenced and finished in 10 hours or less. Half of this is given to molding, and the balance to casting. To prepare and finish 18 molds in 5 hours necessitates doing the work on one in less than 20 minutes. This does not afford much time for the proper carrying out of the many necessary and important details, and with workmen not very expert many chances are taken for imperfect work. The mold having been prepared, however, presumably in a proper manner, the quality of metal poured into it determines vitally the character of the wheel, and the most exacting attention to every detail is necessary in preparing and melting the iron. A chill test block 2 ins. square by 6 ins. long cast from the metal should have a chilled surface 7/8 in. deep; this degree of hardness on the test will give 1/2 to 5/8 in. chilled surface on the wheels. A test bar 1 in. square by 12 ins. long, cast from the mixture, should not break at less than 2,500 lbs. when supported at the ends and loaded at the center.

It is stated by some that proper strength cannot be obtained in a bar of 1 in. section on account of hardness of metal, but the greater part of a wheel is less than 1 in. thick, and if a proper degree of strength cannot be obtained in 1 in. bars, how is it to be obtained in plates of less thickness in the wheels?

After the wheel is cast it is placed in the annealing pit. Properly speaking, car wheels are not annealed. They are slowly cooled, for the reason that in the process of manufacture the outer part of the tread is cooled and set at a degree of heat lower than that existing in the body of the casting (this on account of the chilling process), and the entire casting must again be brought to a uniform heat and cooled evenly. The cooling pits should be in dry ground. If dampness is found and steam is seen arising from the pits while the wheels are cooling, or when they are being removed, shrinkage strains will certainly be found in the wheels, and they will be liable to break in service. When such conditions exist they are always indicated by a reddish color on the wheels when cold.

In regard to mechanical defects, their causes and results, the Pennsylvania R. R. specifications, now under consideration for adoption by the Master Car Builders Association, accept wheels that do not vary more than 1/32 in. from a true metallic ring placed over them. To place such a ring over a cast surface, not tooled, would certainly take 1/64 in. all around, making up 3/32 or 1/16-in. All things considered, to make castings weighing 1/4 ton and over, true to 1/16-in. to center as they come from the foundry, is remarkably good practice, and 1/8-in. is a very low average. With a car wheel the highest point, or rather the greatest diameter, will lead until an excessive condition forces it back to begin the same labor over again, with the apparent result that the cars sway and jolt as they run. The load on a wheel is, say, 5 tons, the speed 30 miles per hour, the variation in diameter from its mate 1/8 in.—diameter, 33 inches. The larger wheel will gain three and one-third times 1/8 in. at every revolution. It will revolve 611 times, and would travel, if it could, 10 ft. more in every mile than the smaller one. Of course it cannot do that; the flange would not permit it; but it gets on somehow, pulling and hauling, grinding and wearing, carrying its heavy load all the time with probably nearly as much power wasted in overcoming defective conditions as would be required to do the real work if proper ones existed.

Again, take the matter of balance. Take the very low estimate of 5 lbs. as the amount each wheel is out of balance; then at 30 miles per hour a 33-in. wheel revolves 306 times per minute, and 1,530 lbs. must be swung around the circle described by its circumference every minute on every wheel under each car (8 wheels); therefore 12,240 lbs. must be swung around every minute. On 30 cars this will amount to 367,200 lbs.. What power is required to swing 184 tons around a 33-in. circle once a minute for 320 minutes, the time it would take such a train to run 100 miles, and what effect does it have on retarding motion?

Ten years ago we made car wheels as many makers do to-day, bought good material, used the best of care and conducted the whole matter as a foundry business. But 7 or 8 years ago we introduced methods that gave a little better information as to the quality of each wheel; the practice of finding that out in service was not exactly satisfactory. Some six years ago the point was reached where a definite system covered every wheel made as an individual thing. This, of course, mainly concerned the wheel as it came from the foundry. It was possible to know whether each one was of proper quality and to have full information on that matter. In the effort to improve, the mechanical features of

the question were opened up and followed, until to-day the wheel leaves the foundry perfect as it can be made there; but not to go to the railway shop to have, perhaps, 15 minutes spent in putting a hole through it and pressing it on an axle. It goes to the machine shop, is bored out, turned absolutely true and balanced. Many say that this is unnecessary and useless work; that it decreases the life of the wheel; that the skin on the chilled surface is the vitally valuable thing that must not be touched by the maker; that a difference in diameter is of no particular account: and that as to rotundity and balance, perfect castings can be turned out of the foundry. I have yet to find any wheel-maker who has had a proper practical experience in the foundry say that wheels can be cast mechanically perfect. No doubt in certain instances; with perfectly new tools, chills, etc., and special effort to produce the best result, castings can be made far more perfect than the average. But chills do not always remain new; ordinary workmen must sooner or later attend to the details. Is it possible to expect a good general result from conditions that will only produce it under special treatment that cannot be given in every case?

So long as this question is determined by foundry practice alone and wheels are used as they come from the foundry, it is certain the conditions necessary will not be obtained. It is necessary to find a true center and finish a wheel from that in a mechanical manner to obtain a proper mechanical condition. One of two things will certainly have to be done. Railways will have to adopt steel wheels, for the mechanical work on which they seem willing to spend hundreds or thousands of dollars, where they question that many cents to obtain in chilled precisely what they seek in steel wheels, or they will have to turn and balance chilled wheels. They are progressing step by step to heavier loads and higher speeds. They are equipping freight cars with air brakes that cars may carry more and run quicker. It is one thing to apply the brakes on a car which, with its load, weighs 30 tons, and runs at 30 miles an hour, and have a brakeman do the work of transferring the power of one man through a 1¼-in. brake-mast, with a leverage of 6 to 8 ins. from center; and it is another thing on a train running at double the speed, with double the load, to put at the command of the engineer on a train of 30 cars a power of 50,000 lbs. per car for instant use. If the air brakes are in proper condition on such a train the engineer has stored up in the air tanks under the cars a total force of 750 tons available for instant use. It will probably make some difference under such conditions whether wheels are round or balanced. It is making the difference now.

The best wheel is the one that will not break, that is mechanically perfect and that will retain its original conditions for the longest time. We have proved to our satisfaction that the chilled wheel can be made to fulfill these conditions, and have a total of 600,000 in every kind of service without one case of breakage, as proof of possible safety. A depth of 1-16 in. chilled iron will give more wear than six times that quantity of steel found in any steel tire. It must be remembered that steel tempered and hardened into cutting-tools, and steel not so treated are very different things, and that the latter condition is always the one found in steel tires. Furthermore, the life of a steel wheel in the severe service of to-day is not all in the flat surface of the tire; it is largely in the flange. To provide proper flange thickness on many steel wheels from 20% to 40% of the tire must be turned off and thrown away. It is difficult to say what the entire result of the imperfect conditions referred to are in the practical operation and expenses, but as a conservative statement, based on long and careful investigation of the subject, I believe that with mechanical conditions such as they should be and such as can be maintained without difficulty on chilled wheels, the cost of power operating traffic carried over them can be decreased from 15 to 20%. The cost of wheel service can be decreased from 25 to 50%, and the the saving in wear on equipment and permanent way will be in like proportions.

We have not studied and worked at it from the one standpoint of chilled-wheel manufacturers, but have obtained all the information possible on the manufacture and use of the different types of wheels in all countries and on the results obtained from them. The table here shown gives a very complete and interesting statement of results obtained from steel wheels in Germany during the past five years. It is instructive to those who consider steel wheels as the only proper thing for safety.

There seems to be some inexorable law that ties some purchasers of chilled wheels down to a price that would not buy common iron castings, and that compels them to hold all wheels of that class as of one value and quality. Wheels 33 ins. diam. weighing 600 lbs., are sold commonly to day for prices that do not net the maker $8, freight and other expenses considered—a net price of 1⅓ cts. per lb. The best car-wheel iron cannot be bought for such a price, and just how the purchaser expects the manufacturer to furnish fuel, merchandise of all kinds, plant, labor, and the general expenses of the business, and produce a good article is a hard question to answer. Fortunately all wheel buyers do not follow such a practice, but so many do that the others think a dollar or two more should produce something extraordinary, when, as a matter of fact, they pay more per lb. for their brake-shoes than they do at the highest price for wheels. If improvements in this matter are to be made, it must be considered from all standpoints and the same influences brought to bear upon it that have produced the highest type of modern engineering, the modern railway.

The Rivers at Johnstown, Pa.

Since the memorable disaster at Johnstown on May 31, 1889, when the greater portion of the city was destroyed by a wave caused by the breaking of the South Fork Dam on the Little Conemaugh River, no provision had until recently been made by the city authorities for protection of the city against floods, nor had the possibility of disaster from other dams on the streams tributary to the Conemaugh River been examined into with any care. When, however, on February 17, 1891, a sudden and startling freshet occurred in both Stony Creek and the Little Conemaugh River, and the business portion of the rebuilt city was inundated to a depth of several feet, great consternation was felt, and the Board of Trade, an organization of the business men of the city, decided that some positive action must be taken to quiet the minds of the citizens and to preserve the credit of the city, the feeling among capitalists being such that it was impossible to negotiate the sale of bonds for street and other improvements which are greatly needed.

Accordingly a committee was appointed to procure the services of a civil engineer to make a thorough examination of all the dams and ponds on the streams tributary to the river in the city, and to report their exact condition, the likelihood of their being broken away in freshets and the amount of damage such event would probably cause in Johnstown. The engineer was further to report the exact extent and character of obstructions which had been placed in the way of the flow of water in the channels in the city limits, and what was needed to be done to reduce to a minimum the danger of inundation of the city in freshets.

The appointment of this committee was due to the exertions of Mr. A. J. MOXHAM, the Vice-President and Manager of the Johnson Street Rail Company, and he was very properly made its chairman.

The committee requested Mr. J. J. R. CROES, M. Am. Soc. C. E., to conduct the desired examinations. The report was submitted to the Board of Trade and a meeting of the citizens on June 19.

Accompanying the report and illustrating nearly every point and place described therein was a set of maps, profiles and photographic illustrations on a large scale, enabling the reader of the report to see before him on the walls of the Board of Trade rooms every dam, reservoir and obstruction to the river channel in the city.

The conclusions reached by Mr. CROES were probably not exactly in accordance with the pronounced views of any one of the various parties into which the citizens are divided, on the subject of the causes of the inundation of the city in freshets, but they appear to have satisfied the committee and commanded their approval. These conclusions are summarized by the engineer as follows:

The only possible source of danger to that portion of Johnstown south of the stone bridge from any structures existing on the streams tributary to Stony Creek and the Little Conemaugh Rivers, is the washing down of logs stored in the lumber company's dam at the mouth of Shade Creek by the breaking away of the splash dam on Clear Shade Creek. In view of the possibility of such an event occurring, it is desirable that provision should be made in the splash dam for the overflow of the water of freshets through a spillway, which can be readily constructed in that part of the dam which is now made of sheet piling only. The rest of the dam should be raised 3 ft. and the cribs filled with stone.

To that portion of Johnstown north of the stone bridge, which was formerly known as Morellville, there is a possibility of disaster from the failure of the saw mill dam and the St. Clair dam on Mill Run. Neither of the dams on this stream can be looked upon as safe.

As regards the rivers within the city limits, the inundation of that part of Johnstown south of the Little Conemaugh in floods, such as (from the experiences of 1887, 1889 and 1891) may be expected every second year, is caused almost entirely by the contraction of the channel of Stony Creek between the south end of Market St. and the point where the Valley Pike strikes the river, about 1,000 ft. below the Baltimore & Ohio R. R. bridge. The contraction of the river between these points produces the raising of the water surface above the Franklin St. bridge to such height as to overflow both the east and west banks and flood Meadowville, Kernville and Johnstown.

The obstructions which have been placed in the way of a full discharge of the water of the Conemaugh river, below the mouth of the Little Conemaugh, do not appear to have ever raised the water above the mouth of the Little Conemaugh to such a height as to overflow the city between Stony Creek and the Little Conemaugh to any great extent. The main volume of water has come into the town over the river banks east and south of Franklin St.

The obstructions to the flow of the Conemaugh River are caused, first, by the piers of the Pennsylvania R. R. Bridge; secondly, by the contraction of the water way below the bridge by deposit of material from the iron works. The raising of the water in the greatest floods which are recorded below the mouth of the Little Conemaugh has been such as to injure the Cambria Iron Co. by flooding their works, but has not been such as to injuriously affect the city of Johnstown south of Walnut St. The water of the great freshets below the bridge has always risen over the lands west of the stream, and the raising of the surface of the ground there to admit of the construction of buildings has not been great enough to prevent such flooding; and the only remedy for this state of affairs is to raise the whole surface of the ground which has been occupied, taking care to leave in addition to that a sufficient channel for the stream—that is, a channel having 5,000 sq. ft. of waterway.

As regards the stone bridge of the Pennsylvania Railroad, experience has shown that the five openings of the stone bridge which are in the waterway of the river are insufficient to pass the water of the greatest floods recorded, but that the water rose 7 ft. over the east bank and flowed through the two openings that are used for travel. It is desirable to lower this flood water at least 2.5 ft., so as to make the surface slope of the stream uniform through the city, and this can be accomplished by the clearing out of six of the openings between the piers.

This would afford sufficient waterway for any freshet which has so far occurred, but would not afford room enough for the passage of such a freshet as may occur, judging from the experience of other similar streams. Such a freshet would probably raise the water nearly 5 ft. higher at the bridge and back the water of Stony Creek up to Poplar street, making it at Franklin St. Bridge about the same height as the flood of June 7, 1887.

This is the worst that could be expected, and no damage

STEEL TIRES BROKEN ON THE RAILWAYS OF THE GERMAN EMPIRE; 1884 TO 1889.

Years.	CAST STEEL.			FUSION STEEL.			MARTIN STEEL.			MANGANESE STEEL.			BESSEMER STEEL.			OTHER STEEL.			PUDDLE STEEL.			Number of Steel Tires on hand and in use.	No.	Per Cent.
	On hand and in use.	Broken. No.	Broken. Per Cent.	On hand and in use.	Broken. No.	Broken. Per Cent.	On hand and in use.	Broken. No.	Broken. Per Cent.	On hand and in use.	Broken. No.	Broken. Per Cent.	On hand and in use.	Broken. No.	Broken. Per Cent.	On hand and in use.	Broken. No.	Broken. Per Cent.	On hand and in use.	Broken. No.	Broken. Per Cent.				
1884....	106,838	259	0.24	197,573	295	0.15	53,922	52	0.10	1,835	....	.....	380,189	834	0.22	6	.....	.....	201,582	1,410	0.70	941,945	2,853	0.30
1885....	94,365	370	0.39	221,217	464	0.21	66,848	117	0.16	1,464	6	0.41	402,140	1,208	0.30	302	16	5.30	173,151	1,378	0.79	959,682	2,749	0.37
1886....	96,099	294	0.31	189,658	500	0.26	93,694	177	0.19	2,039	.....	.....	453,857	1,771	0.39	244	32	13.0	167,015	1,214	0.77	9 2,636	3,588	0.40
1887....	99,768	267	0.27	129,232	304	0.24	171,370	169	0.10	1,767	17	0.96	471,080	1,389	0.30	214	28	18.08	134,615	780	0.58	1,067,516	,304	0.29
1888....	92,203	348	0.38	115,617	380	0.33	204,952	241	0.12	1,419	18	1.20	510,925	1,498	0.29	170	68	40.0	115,887	8.1	0.71	1 041.135	3,854	0.37
1889....	64,059	1 4	0.27	140,635	311	0.22	284,815	241	0.08	1,251	.....	.....	510,985	1,909	0.37	440	65	14.8	100,456	680	0.68	1,102,941	5,320	0.31

to Johnstown could result from it, provided that at all points along the line of the stream from one end of the city to the other where the natural surface of the bank is below the assumed flood level, as indicated on the profiles and plans, the banks of the river be protected by dikes carried up to a proper height above the assumed maximum level, and such height should range from 5 ft. at the stone bridge to 2 ft. at the Baltimore & Ohio R. R. bridge at sta. 218.

With the channel widened and where necessary deepened in the manner indicated on the plans and profiles, and hereinbefore recommended, I believe that the great and ever imminent danger to Johnstown from being inundated by the water of Stony Creek flowing into the city over its banks between the Baltimore & Ohio R. R. bridge and the Franklin St. bridge, may be permanently averted. Without the rectification of the channel between these points such danger will always exist.

The report is shortly to be published in full, with all the illustrations.

Care and Maintenance of Electric Block Signals.

At the last annual meeting of the Association of Railway Telegraph Superintendents Mr. G. L. LANG, of the New York & New England R. R., read a paper on the maintenance of electric block signals, of which the following is an abstract:

First of all, select an intelligent man to take care of the signals, and impress upon him that eternal vigilance is the price of a perfect-working signal. He should clean his battery zincs very often to keep the internal resistance at the minimum, the external resistance being merely nominal.

A point not very generally understood by batterymen is that a battery that will work a 4-ohm sounder for 2 weeks will only work a signal circuit of half an ohm resistance one week.

When the zinc becomes reduced one-half in size no change is noticed in a circuit of high resistance, but it is fatal to a circuit of very low resistance. On the N. Y. & N. E. R. R., there are 2 circuits of different resistance; one from 0.5 to 2 ohms, the other from 10 to 20 ohms. The half-consumed zincs are transferred from the lower to the higher resistance circuits, keeping up the efficiency of both batteries. The speaker said that fully nine-tenths of the failures recorded on block signals can be legitimately charged to the battery, showing that this is the main point to watch.

Another point that, if carefully and intelligently watched will save much anxiety and search for cause of trouble, is the relay.

Every relay should be hermetically sealed, so no dust can prevent the points from making sure and perfect connection. Every relay should be protected by a lightning arrester of some kind, as, strange as it may appear, relays in a circuit made up of the steel rails of the track and underground wires, with no line wire whatever, are often burned by lightning. Where the track is the circuit the joints are usually bridged by wires fastened to the rails by rivets driven into holes drilled for the purpose. Here is something that requires very close watching.

The track workmen are often ignorant, careless or both, breaking the wires or loosening the wires on the rivets. A detecting galvanometer is a very valuable help in locating faults of this nature.

In systems using the tracks for the circuit, insulations are necessary to divide the track into suitable signal sections, as well as for other purposes. These require great care in first introducing, as well as watching from day to day.

The insulating material may be of wood, vulcanized fiber, leatheroid, laminated fiber or other suitable material. The exact manner of introducing these insulations varies on different roads.

The cost per signal for maintenance of double-track block signals is not far from $40 per annum, varying somewhat according to the traffic. Notwithstanding the expense of installing a complete signal system and expense of care, the speaker believed their use to be an economy when the traffic is as heavy as is the case on some parts of many of our leading railroads.

PERSONALS.

Mr. WM. G. WALLER, civil engineer, died at Baton Rouge, La., June 13.

Mr. G. L. NICHOLSON has been appointed Engineer and Superintendent of the Chesapeake & Ohio Canal.

Mr. E. P. GARDNER has been elected Superintendent of Water-Works at Norwich, Conn., vice Mr. JUNIUS A. BRAND.

Mr. N. O. DUERR, formerly with Cofrode & Saylor, has resigned to take charge of the office of the Toledo Bridge Co., Toledo, O.

Mr. J. F. BOYD has been appointed Superintendent of the Mont Alto R. R., Pennsylvania, vice Mr. GEORGE B. WIESTLING, deceased.

Col. JOHN LEE, who had been interested in railways in Indiana since 1869, and president of a number of railways in that state, died at Crawfordville, Ind., June 18.

Mr. WM. TORREY, the originator and chief promoter of the Raritan & Delaware Bay R. R., now the New Jersey Southern R. R., died at Manchester, N. J., recently.

Mr. W. F. DURAND, of the Department of Mechanism, Michigan Agricultural College, has been elected Professor of Mechanical Engineering at Purdue University, Lafayette, Ind.

Mr. FRANCIS E. GALLOUPE will sail from Boston, on steamer *Scythia*, June 27, for a three months' trip abroad. Mr. GALLOUPE is the compiler of the ENGINEERING NEWS general index.

Mr. F. A. DUNHAM, of Plainfield, N. J., engineer of the excellent highways of Union Co., has been elected City Engineer of Dunkirk, N. Y., with special reference to the improvement of the streets of the city.

Gen. ALBERT G. BLANCHARD died at New Orleans, La., recently. Previous to the civil war he made the surveys for the New Orleans, Opelousas & Great Western R. R., now a part of the Southern Pacific system.

Mr. HENRY W. ROGERS has resigned his position as Superintendent of Water-Works at Salem, Mass., and has accepted a similar post on at Milford, Mass. He is a past president of the New England Water-Works Association.

Mr. V. E. MCBEE has been appointed General Superintendent of the Georgia Central R. R., and Mr. R. B. BRIDGES has been appointed Superintendent of the Western North Carolina Division, vice Mr. MCBEE, promoted.

Mr. S. B. BURTON has been appointed Superintendent of the Tampico division of the Monterey & Mexican Gulf R. R., with headquarters at Victoria, Tex. Mr. T. C. RAY has been appointed General Agent at Tampico, Mexico.

Mr. WM. J. HAMMER, for a number of years identified with the Edison interests, and manager of the Edison exhibit at Paris in 1889, has opened an office at Temple Court, New York City, as a consulting and Supervising Electrical Engineer.

Mr. GEORGE B. BURBANK has been appointed resident consulting engineer to the Cataract Construction Co., which is building the water-power tunnel at Niagara. He has been a division engineer on the new Croton Aqueduct, and in charge of the construction of the Sodom dam.

Mr. C. C. MARTIN, for a number of years the Chief Engineer and Superintendent of the Brooklyn Bridge, has been offered the position of managing director of the Rensselaer Polytechnic Institute, at Troy, N. Y. The office is equivalent to that of President in other colleges. It is not yet known whether Mr. MARTIN will accept.

Mr. GEORGE B. WIESTLING, President of the Mont Alto Iron Co. and Superintendent of the Mont Alto R. R., died at Chambersburg, Pa., June 17. In early life he was a civil engineer on the Pennsylvania R. R., and built the tunnel at Oxford Furnace, N. J., on the Delaware, Lackawanna & Western R. R. He was a member of the American Institute of Mining Engineers.

Mr. SAMUEL H. KETTLEWELL died recently at Baltimore, Md. He was a topographical engineer for the commission which laid out the boundary between the United States and Mexico after the Mexican War. He was also astronomer and topographical engineer for the expedition to lay out the line for a canal across the Isthmus of Darien. During the civil war he joined the Confederate Army, and was topographical engineer to the Army of Northern Virginia.

NEW PUBLICATIONS.

—*An Explanation of the Principles and Operation of the Mannheim Slide Rule.* By C. W. CROCKETT, Assistant Professor of Mathematics and Astronomy, Rensselaer Polytechnic Institute. Troy, N. Y.: E. H. Lisk. Cloth, 8vo, pp. 26, cuts.

An excellent little book, especially for schools, has been prepared by Professor CROCKETT, and is published with the above title. Like the similar work of Mr. WM. COX, it deserves a wide circulation, and one or the other should be in the hands of every student of engineering.

—*California's Irrigation System.*—In our issue of Sept. 14, 1889, attention was called to an article entitled "How to Make the Desert Blossom as the Rose," which appeared as a supplement to the San Francisco *Chronicle* of Aug. 23, 1889. The same paper in its issue of June 7, 1891, devotes over 12 pages to "California's Irrigation System." The demand for information regarding irrigation is now so urgent and the articles in the *Chronicle* contain so much interesting and valuable matter that it seems proper to call especial attention to the latter, as we did to the earlier résumé.

The *Chronicle* first gives a general review of irrigation development in California and the questions now pressing for settlement. It then refers to irrigation practices and regulations in India, Spain, Italy, France and Australia, briefly describing some of the most important works in those countries. The general subject, what irrigation has done for California, is next discussed. In this connection many figures are given to show the rapid increase of wealth and population in the irrigation counties, the crops that may be raised with the aid of irrigation and the nature and extent of irrigation enterprises within the state. In comparison the irrigation progress in other states is briefly reviewed.

Perhaps the most interesting and valuable part of the résumé is that relating to Irrigation Districts, as formed under the "Wright Law" of 1887 and its amendments. This law took its name from Mr. C. C. WRIGHT, of Modesto, who introduced the bill in the California Legislature. The bill and its amendments of 1889 and 1891 are given in full in the *Chronicle*, and are supplemented by State Supreme Court decisions establishing the constitutionality of the law.

Following the law are letters approving it or describing its operations and objects by Messrs C. P. HUNTINGTON, A. L. RHODES F. G. NEWLANDS C. C. WRIGHT, the author of the law, and J. R. JARBOE. These letters are supplemented by numerous interviews with and letters from prominent San Francisco and California business men, strongly in favor of the Wright Act and enthusiastic over what irrigation is doing for California.

Finally, over three pages are given to a detailed historical and general description of 13 of the 30 or more irrigation districts already formed in California. The Bear Valley Irrigation Works also being described.

The matter relating to irrigation districts is very timely, and will be welcomed by all who are interested in irrigation, whether in the actual construction and operation of irrigation works, the extent of irrigation enterprises, or the relation of State and Federal governments to the subject. For years California has been the scene of almost endless conflicts over water rights. The courts have been crowded with such cases, and the natural development of the state has been greatly retarded by both land and water monopolists, each class having been able to hold its own because one natural gift without the other was valueless, and because small holdings of land meant ruin to the owners unless water could be secured for irrigation. By virtue of the Wright Act the people in any section naturally watered from one source may, if they so elect, organize a district, vote bonds, build and operate irrigation works and raise taxes on all the property within the district benefited by the works, to pay the interest on the bonds. This plan combines the ownership of land and water, and makes small holdings of land profitable, because the benefits of large water undertakings may be secured without submitting to the high rates often charged for water for irrigation. Thus it seems that government aid, in the construction of irrigation works, will be rendered altogether unnecessary, much to the relief of all who deplore the centralizing tendencies of the times.

—*Progress Report on Irrigation in the United States. Part I.*—Prepared under direction of the Secretary of Agriculture by R. J. HINTON, Special Agent Artesian, Underflow and Irrigation Investigation, 1891. Pub. Doc. Pamph., pp. 337, including a full index; illustrated.

The work reported upon in this volume has been done under an act of Congress approved April 4, 1890, which appropriated money "for the purpose of determining the extent and availability for irrigation of the underflow and artesian waters in the region between the 97th degree of west longitude and the eastern foothills of the Rocky Mountains," and which also directed the collection and publication of "information as to the best methods of cultivating the soil by irrigation." The work of investigation has been divided into three parts: an office of irrigation inquiry, in charge of Mr. HINTON; engineering field work and inquiry, under Mr. E. S. NETTLETON; and geological investigations, under Prof. ROBERT HAY. Mr. NETTLETON'S report forms a separate volume, which will be noticed in another issue.

A large part of the volume under review is taken up by Mr. HINTON'S progress report for 1890, under the title "Irrigation in the United States." The first part of this report is largely historical, being a brief sketch of the growth of irrigation in this country, and an examination of the character and effect of irrigation progress. A notable tendency in very recent years is the breaking up of land into small holdings, especially in California. The writer discusses in some detail the various sources of available water supply, the relation of rainfall to irrigation and allied subjects. The altitudes of the various interested states toward irrigation and their legislation on the subject are also discussed by Mr. HINTON, and some of the most important irrigation works in the country are

described, as are tools used and methods of distributing water.

The following estimates of land under ditch in 1889 and 1890, and of lands actually cultivated in 1890, are taken from the report:

	Under ditch, acres.		Under cultivation, acres.
	1889.	1890.	1890.
Arizona	529,200	643,450	310,100
California	3,294,000	4,044,000	3,444,000
Colorado	2,813,273	4,004,009	1,585,000
Idaho	715,500	1,181,500	327,000
Kansas (western)	509,000	860,010	100,000
Montana	986,000	1,100,000	400,000
Nebraska (western)	50,000	65,000	10,000
Nevada	142,000	150,000	75,000
New Mexico	638,455	677,315	450,000
Oregon (eastern)	75,000	100,000	45,000
South Dakota (Black Hills)	100,000	100,000	20,000
Elsewhere in Dakotas	.....	2,000	2,000
Texas	200,000	340,000	160,000
Utah	700,000	700,000	413,000
Wyoming	1,946,876	1,946,876	175,000
Wyoming (eastern)	75,000	150,000	60,000
Totals	12,764,304	16,064,160	7,576,100

From the above figures it will be seen that in one year there was an estimated increase of land under ditch of about 3,300,000 acres, or over 25%, while in both years the two states of California and Colorado had about half of all the land under ditch, and in 1890 about two-thirds of all the land under cultivation. In 1890, according to the estimates, less than one-half of the land under ditch, or potentially supplied with water, was actually under cultivation. It is not claimed that these figures are accurate, but as estimates it is thought that they approximate closely to the truth, and form a fair basis of comparison.

Professor HAY'S report as Chief Geologist is of progress merely, although observations are made on the cost of irrigation methods, rivers of the plains and mountains in connection with irrigation, and also on the underflow.

Progress reports for various sections are made by Mr. J. W. GREGORY, Mr. J. W. NIMMO, Jr., Prof. L. G. CARPENTER and Mr. C. W. IRISH. There are also special reports as follows: "Phreatic Waters in Nye Co., Nev.," by Mr. GEORGE NICHOLS; "Imbibition of Rocks," by Mr. R. T. HILL; "Cultivation of the Raisin Grape by Irrigation," condensed from a publication by Prof. G. W. EISEN; "Irrigation in Australia," by Mr. R. J. HINTON; "Notes on the Experience of Other Countries in the Administration of their Water Supplies," a paper by Mr. H. G. MCKINNEY; and some other abstracts and observations relating more or less directly to irrigation.

The report will be welcomed by all who are interested in irrigation, and all the more so because of the scarcity of matter relating to irrigation works and practices in this country.

TRADE PUBLICATIONS.

—*Treatise on Cement.*—Lawrence Cement Co., New York. Paper, 4½ × 6½ ins., pp. 44.

This treatise is devoted to the Hoffman Rosendale cement manufactured by the company, dealing with its manufacture, properties and qualities, and showing its application to different classes of work. It also contains directions for mixing and using the cement, and for making concrete, grout and cement mortar. There are tables of excavation, amount of material for lining, etc., of cisterns, and also a number of testimonials. There is also a reprint of the report made in 1885 by a committee of the American Society of Civil Engineers on a uniform system for tests of cement.

—*Electric Coal Cutters as manufactured by the Edison General Electric Co.*—Pamphlet, 16mo, pp. 22. Edison General Electric Co., New York.

This small pamphlet contains an outline of the method of coal mining by undercuts, and a description of the undercutting machines used in connection with an Edison motor. While the use of electic motors with such cutters is by no means new, the Edison General Electric Co. has placed a machine on the market that seems to possess many excellent features, and will probably prove as satisfactory as the company's other specialties.

The average cost of equipping a mine with the electric plant necessary for mining 400 tons per day in a 5-ft. vein of bit coal (the plant being operated 20 hours per day) is stated to be about $9,500. This does not include steam engine, boilers and building.

SOCIETY PROCEEDINGS.

Association of Railway Telegraph Superintendents.—The tenth annual convention was held in Cincinnati June 17 and 18. New officers were elected as follows: President, C. S. Jones, Ill. Cent., Chicago; Vice-President, L. H. Kortz, U. Pac., Omaha; Secretary and Treasurer, P. W. Drew, Chicago. The first day's session was chiefly occupied in discussing the matter of Union employees. The following papers were on the program: "Time and Time Signals," by W. F. Gardner; "Care and Maintenance of Electric Block Signals," by G. L. Lang; "Electric Railways," by S. S. Bogart; "Use of Phonophone in Railway Service," by M. B. Leonard; "The Train Wire," by Robert Stewart. The next annual meeting will be held in Denver, Col. June 15, 1892.

American Railway Master Mechanics' Association; Annual Meeting at Cape May, N. J.

(*Concluded from page 591.*)

THURSDAY'S SESSION.

The convention was called to order at 9 A. M. by the President, the first business before the meeting being the discussion on the report on operating locomotives with different crews. The discussion was opened by Mr. John A. Hill, a member of the committee, who only reaffirmed the opinions expressed in the report. Mr. Wm. Swanston, of the Chicago, St. Louis & Paducah R. R., regarded the double-crew system as the best on the whole, though he also used the chain-gang system. In some runs six men to four locomotives were used, and so far the plan had worked fully as well as giving each man his engine, and, as far as could be seen, had not increased expenses.

Mr. O. Stewart, of the Fitchburg R. R., stated that the practice of this road was to give each man an engine as far as possible, otherwise to double-crew. All locomotives are inspected upon return to the roundhouse by a special inspector, and the engineers are also required to make a report of the condition of the engines and necessary repairs if any. The subject of the comparative expense of fuel of the double-crew and chain-gang systems had been tested by the road, and for the period covered by the tests six months, there was a difference of only 0.5 of 1% in favor of the double-crew system.

The report of the Committee on Locomotives for Heavy Passenger and Fast Freight Service, published in abstract in our last issue, was then read. The discussion was largely upon the comparative safety of the pony and four-wheel trucks, as used by the mogul and ten-wheel locomotives, and the respective merits of the vertical and angular truck hangers.

Mr. Pulaski Leeds, of the Louisville & Nashville R. R., thought that with the vertical hanger too free lateral motion was permitted, which chafed the driving-wheel flanges and caused them to become sharp in an unreasonably short time. On the other hand, Mr W. L. Austin considered the vertical hangers preferable, as they tended to distribute the weight on both drivers when rounding curves, instead of throwing it largely upon one, as was the case with angular hangers.

Mr. J. N. Lauder, of the Old Colony R. R., stated that his experience confirmed the opinion of Mr. Leeds. In regard to the comparative merits of the mogul and ten-wheel types for the service under consideration he regarded it largely a question of location, something a question of prejudice and very little a question of fact. He considered the pony truck perfectly safe. Mr. M. N. Forney regarded the pony truck as the safest, as in operation the truck axle assumed a position more nearly radial to the curve, which was theoretically the correct position. Mr. Angus Sinclair thought that the real question at issue was the question of maintenance. The mogul engine when in good order was as safe as a ten-wheel in good order. The question was, which could be kept in good order at the least expense.

The next question taken up was the report on Electrical Appliances for Railway Use. The committee was unable to present any report upon the subject, owing to lack of data regarding the use of electricity by railways. A few railways were using some of the various electrical devices for lighting and signaling, but it was mostly in an experimental way. The committee suggested that a new committee consisting of members connected with such roads as were using electricity in any way be appointed to investigate the matter.

Some little discussion followed as to the advisability of appointing a new committee, and it was decided to drop the matter until more substantial progress had been made with the use of electricity for railway purposes.

The report of the Committee upon Standards of the Association, published in abstract in our last issue, was next read, and accepted without any important discussion.

The report on Air Brake Standards and Inspection and Care of Air Brakes was then taken up. The report was made by a joint committee from the Master Mechanics' and the Master Car Builders' associations and was given in our issue of June 13. There was little discussion, and upon motion of Mr. Geo. Gibbs the rules were placed on file and the committee continued for another year.

This closed the reports of the committees, and the convention proceeded to the election of officers and general business. The old officers, consisting of President, John Mackenzie; First Vice-President, John Hickey; Second Vice-President, Wm. Garstang; Treasurer, A. Stewart, and Secretary, Angus Sinclair, were unanimously re-elected.

The following were appointed a committee on subjects for discussion at the next meeting: Geo. Gibbs, Wm. Smith and Jas. Barnett.

The committees on the following subjects were continued for another year: Exhaust Pipes, Nozzles and Steam Passages; The Present Status of the Car-Coupler Question; and Air-Brake Standards, and Inspection and Care of Air Brakes. Reports will also be presented on the following subjects at the next annual meeting: Locomotive Indicating; Compound Locomotives, and Uniform Practice of Compiling Locomotive Performances.

The noon hour was taken up with a general discussion of compound locomotives, turning largely upon the relative merits of the Baldwin four-cylinder type of compound and the two-cylinder type of compound as built by the Schenectady Locomotive Works.

Resolutions of thanks were tendered by the Association to Congressman Reyburn, to the various entertainment committees, to the officers of the Association and to the *Northwestern Railroader*. The meeting was then adjourned, to assemble again on the next Monday after the second Wednesday in June, 1892.

EXHIBITS.

The following is a list of the firms having exhibits at the Master Mechanics' Convention, in addition to those published in our report of the Master Car Builders' Convention, June 13:

Dyer Williams, Williams automatic car coupler, M. C. B. type; Page, Newell & Co., model of Brunswick steel-tired wheel; C. W. Hunt Co., Hunt coal conveyor; L. C. Chase & Co., car plushes; Welsh Mt. Mining Co., clay, fire sand and kaolin; National Car Spring Co., locomotive spring; H. L. Howe, air brake triple valve; Bundy Mfg. Co., Bundy time recorder; Watson & Stillman, hydraulic jacks, wheel presses, crank pin presses; Falls Hollow Staybolt Co., patent mandrel-rolled hollow staybolt iron; Northwestern Equipment Co., rectangular brakebeam; McLeod Car Heating & Ventilating Co., steam coupler, prints showing system; Ewald Iron Co., staybolt iron, firebox steel; Mason Regulator Co., air brake regulators, reducing valves, pressure regulators; United States Metallic Packing Co., samples of packing; Jenkins Bros., valve disks; C. F. Hall & Sons, machinery for refitting valves; Fairbanks & Co., high-pressure straightway valve; Car Truck Supply Co., anti-friction side bearing, Elmore box lid; National Hollow Brakebeam Co., models of hollow brakebeam; National Electric Headlight Co., Pyle automatic electric headlight, and L. Schutle & Co., injectors and jet condenser.

American Society of Mechanical Engineers. Providence Convention.

(*Concluded from page 589.*)

At the final session of the convention on Thursday morning, June 18, the first paper presented was that by Mr. H. M. Howe on "Manganese Steel," published in our last issue. Mr. G. C. Henning said that a peculiar quality of manganese steel was its slight resistance to crushing. In testing specimens for Mr. Hadfield some time ago he found much difficulty in obtaining the full tensile strength on account of the crushing of the test piece in the holders before the strain on the specimen reached the breaking load. He regretted that in the tests of resistance to abrasion the wear on the shaft and on the emery wheel were not given, and that the wear of manganese steel was not tested also when rubbing against some of the softer metals like mild steel. Since resistance to abrasion is one of the most valuable properties of manganese steel, its behavior when subjected to abrasion should be tested under as many different circumstances as possible. The mode adopted for testing the car wheels by dropping them from a height so that they struck flange first on a steel block was especially unfair to the cast-iron wheel, and was a most inaccurate method. Also the "total height of drop," given in the table, was wholly meaningless, as some of the drops did not strain the wheel beyond the elastic limit, and there was no uniformity in the drops used for the different wheels.

In the drop tests of axles, it should have been explained that the axle was turned after each blow, so that the impact was upon the convex side; otherwise the "total deflection" given was liable to be misunderstood. It is also not certain whether the height of drop is measured to the point of impact (the axle being bent upward) or to the level of the bearings. [It was afterward explained that it was to the level of the bearings.] On the whole, however, the showing for manganese steel is most remarkable, and it appears to be superior to ordinary steel for most purposes, except where considerable resistance to crushing is required.

President Hunt, referring to the use of manganese steel for car wheels, gave some interesting particulars concerning the Fowler steel wheel. This wheel, as most of our readers know, is made by placing a solid cast-steel wheel at a red heat in a machine which rolls and compresses the tread until the diameter is reduced from ½ in. to ¾ in., and the tread is compacted and made stronger and more durable. The great difficulty has been to obtain a metal which will endure this rolling. Lately, a soft steel made by the Bookwalter process has been used, containing only from 0.22 to 0.30% of carbon. This has been a very soft metal for a wheel tread, of course; but the inventor has based his expectations of durability on a physical hardness, produced by the severe rolling which the tread receives in manufacture. Mr. Hunt thought, however, that the expected durability of tread had not yet been attained. Another solid steel wheel company, having its home in New England, seems to be meeting with a fair degree of success. An important consideration in the success of manganese steel will be the price at which it can be produced. The wonderful results attained by

makers of cast-iron car wheels makes it difficult for steel wheels of any type to succeed commercially.

In closing the discussion, Mr. Howe said that while manganese steel does not stand well as a rule when subjected to compression alone, there is great difference in the different grades, and some endure compression much better than others. There is about the same difference between castings and forgings that exists between castings and forgings of carbon steel. So far as known there is not much difference in the waste in scrap in making castings in manganese steel and in carbon steel. There is some difficulty in cutting off the sinking head and runners in casting manganese steel, owing to its excessive hardness, but it can be overcome largely by trimming the casting while hot.

A criticism of the figures of mileage made by street-car wheels, given in Mr. Howe's paper, will be found on our editorial page.

PERFORMANCE OF A WORTHINGTON HIGH-DUTY PUMPING ENGINE.

This paper, by Prof. J. E. Denton, described a series of tests on a Worthington high-duty pumping engine working on a pipe line of the Standard Oil Co., against a head equivalent to 2,400 ft. of water. The tests showed a steam consumption of 16.4 lbs. per I. HP. The duty per 100 lbs. of coal (supposing the boiler to supply to the engine 10 lbs. of steam per pound of coal burned) is 116,500,000 ft. lbs. The engine is direct acting, and the stroke varies only 1% as a maximum, the average being 37¼ ins. The average slip was only 1.36%. In an early issue we shall give a fuller account of the test and the results obtained.

In presenting his paper, Prof. Denton added greatly to its interest by illustrating it with the stereopticon, and describing the most interesting features of oil transportation by the pipe-line system. Mr. F. M. Wheeler said it was very remarkable that so steady and complete a stroke should have been made by the engine. The very small slip and the high piston speed were especially worth notice. Prof. Denton said, however, that there were no special arrangements for securing a regular length of stroke, and the engine was tested in its usual working condition.

A BLAST-FURNACE BLOWING ENGINE.

In this paper Mr. Fred. W. Gordon, of the well-known firm of Gordon, Stroebel & Laureau, described what is practically the usual American type of blowing engine, with some improvements in detail, which were proposed as a standard form and on which criticism was invited. A spicy debate took place over this paper, and Mr. Gordon's engine was the subject of sweeping criticism from some and praise from others. We shall publish the paper and discussion soon.

EXPERIMENTS WITH A SCREW-BOLT.

In this paper Mr. Jas. McBride described some experiments to determine the amount of power lost in friction in turning a nut on an ordinary 2-in. screw-bolt. He found that only 10.19% of the power applied to the wrench was actually effective in putting a strain on the bolt, the remaining 89.81% being lost in the friction of the nut on the washer and on the threads of the bolt. The paper was discussed by Wilfred Lewis, of Philadelphia, who gave the following formula for the efficiency of a screw:

$$\text{Efficiency} = \frac{\text{Pitch}}{\text{Pitch} + \text{diameter}}.$$

MECHANICAL STOKERS.

A paper by W. R. Roney, inventor of the Roney Mechanical Stoker, was then presented by the author. This is the first paper ever read before the society on this topic, and in view of the rapidly growing use of mechanical stokers it was quite opportune; we shall reprint it at an early date. Unfortunately the hour for closing was so near at hand that scant time was available for the reading of the paper, and there was no discussion. Of the long list of topical questions, only three had been disposed of, and No. 96 was taken up by special request.

"Can a pyrometer, made by inclosing a small amount of water in a hermetically sealed metallic chamber, and showing the degree of heat by the length of time taken to raise the interior of the chamber to a given pressure, be made to work successfully?" The question was asked by Mr. A. F. Nagle, of Chicago, and was answered by several members. Mr. Geo. H. Barrus and Mr. W. F. Durfee doubted the practicability of the device, and the latter said that the Siemens pyrometer was of this class. Mr. D. L. Barnes thought it might work, if properly calibrated, in case it could always work subject to the same conditions; as a universal pyrometer, however, he doubted its value. H. M. Howe said that as the Le Chatelier pyrometer was proving such a success, being able to indicate very high temperatures with a maximum error of 10°, he saw no reason for getting up a water pyrometer. In answer to questions, he said the Le Chatelier pyrometer could be obtained from Queen & Co., of Philadelphia, and the price was about $100. Mr. Carleton W. Nason thought that the variations in the rate of heating of a water pyrometer as proposed, owing to the varying rate of circulation of the fluid over its surface, would make the scheme impracticable. Prof. W. A. Rogers thought that the pyrometer operated by the expansion of metal bars was the best yet invented. It was now possible to detect a difference in length of the pyrometer bars amounting to $\frac{1}{200000}$ of an inch, or even in some cases to $\frac{1}{1000000}$ of an inch.

A member of the Committee on Standard Pipe Flanges stated that no report was ever made by that committee, and many of its members were now engaged in other lines of work, where the investigations necessary would not be of interest to them. He requested, therefore, that the committee be discharged. It was so voted.

A number of members then offered resolutions of thanks to Mayor Charles Sidney Smith, of Providence; to the Providence street railways, which carried members of the convention without charge; to the various manufacturers who opened their works for the inspection of the visitors; to the Advance Club, the Historical Society, the Providence Public Library, the Franklin Society and the Library of Brown University; to Commander Theodore F. Jewell, U. S. N., and his associate officers; and last, but far from least, to the local committee.

It was announced that the annual meeting will be held in the society's house in New York City some time during the month of November. President Hunt congratulated the members on having held the most successful meeting in the history of the society, and declared the session closed.

ROCKY POINT AND NEWPORT.

From the convention hall the members proceeded to the wharf, where the excursion steamer *Bay Queen* was in waiting. Besides those in attendance on the convention many residents of Providence were invited to join in the afternoon's pleasure, and the number on board the boat was about 475. The weather was cold and misty, with an occasional dash of rain, which did not serve, however, to dampen the spirits of the crowd. At Rocky Point the party disembarked and were treated to a genuine Rhode Island clambake. Then taking the steamer again, the party proceeded down the bay to Newport. Some time before reaching there, those on the stern of the boat saw far in the rear a small, dark-colored boat, with a large funnel, following in the wake of the steamer and rapidly overtaking her. "The *Stiletto*," was every one's guess; and as the boat came nearer there was no doubt on the question. Everybody cheered and shouted as the swift little boat came close alongside and dashed past the big excursion steamer as if the latter were standing still. After running a quarter of a mile ahead of the *Bay Queen* the *Stiletto* made a sharp turn and ran back to the rear; then, after following in the wake for a while, she put on a full head of steam, flew past the excursion boat again, and led the way toward Newport. At Newport the excursion steamer stopped in front of the Government torpedo station, and the party witnessed the explosion of a number of submarine mines. A few of the members who wished to take evening boats homeward were landed at the wharf, and the steamer then sailed up the bay to Providence. A landing was made at the wharf of the Narragansett Electric Lighting station, and most of the party left the boat at this point. The power plant at this place consists of two triple-expansion Reynolds-Corliss engines. One has cylinders 14 ins., 25 ins. and 33 ins. diameter and 48-in. stroke and makes 100 revolutions per minute. The indicated horse power in the test reported by J. T. Henthorn in a paper abstracted in our last issue was 517.7, and the steam used (at 125 lbs. pressure) was 12.9 lbs. per I. HP. per hour. The larger engine is of the same pattern with cylinder diameters of 21 ins., 36 ins. and 50 ins., and the power is transmitted from the 16-ft. flywheel by a 72-in. belt running at the rate of over 5,000 ft. per minute. An auxiliary 16 × 24 Armington & Sims engine, running at 192 revolutions per minute, is also in use. The boilers are in three batteries, and were built by the National Water-Tube Boiler Co. and the Babcock & Wilcox Co. The electric systems used are the Thomson-Houston for arc lighting and power, and the Westinghouse for incandescent lighting.

FRIDAY'S EXCURSIONS.

The forenoon of Friday was devoted to visiting various manufactories in Providence. The Corliss engine works was the first on the list. As the invitation to this place had not included those members who were engaged in engine building, the other members were on the lookout for things of special interest here. If any "trade secrets" were found out, however, the writer did not hear of it. The shops were well filled with work, and most of the engines turned out are of large size. The shops and their fittings seem rather old-fashioned. All the work is handled by jib cranes, and the lighting of some of the shops is rather poor.

At the Rhode Island Tool Co.'s works the principal article of manufacture seemed to be nuts, of all kinds and sizes. The methods used were hardly up to the best modern practice, however, many machines being fed by hand, the operator placing the nuts in position, one at a time, which, with a little ingenuity, might be made to feed automatically with a material reduction of the labor cost.

Returning to the omnibuses the party was carried to the high service pumping station of the Providence Water-Works. There are two pumping engines here which date back to the days when novelties in steam pumping machinery were the rule. The oldest of these was built by GEO. H. CORLISS in 1873, and consists of ten horizontal cylinders radiating from a common center and connected to a single crank pin. The steam cylinders and water cylinders alternate with each other; the former are 20 ins. in diameter and the latter 12 ins. The engine was rather a failure in point of economy. The other engine is a compound vertical pump, built in 1876 by the Providence Steam Engine Co., and described and illustrated in ENGINEERING NEWS October 7, 1876.

The omnibuses then went on down the hill through some of the finer residence portions of Providence to the works of the American Ship Windlass Co. This firm makes all sorts of capstans and windlasses for ship and dock use, working by either steam or hand power. What interested the visitors more than the machinery or products of the firm, however, was a luncheon which was spread in the pattern shop, and like most things turned out of a pattern shop, it was finished in excellent shape.

PAWTUCKET AND ITS PUMPING ENGINES.

From the ship-windlass works the party was taken to the railway station, where a special train was in waiting to carry the members to Pawtucket. The chief thing of interest at this point, of course, was the water-works pumping plants. The very thorough tests made on the Corliss pumping engine at station No. 1, by Prof. J. E. Denton, were described in a series of papers from his pen, in ENGINEERING NEWS of December, 1889, and January and February, 1890.

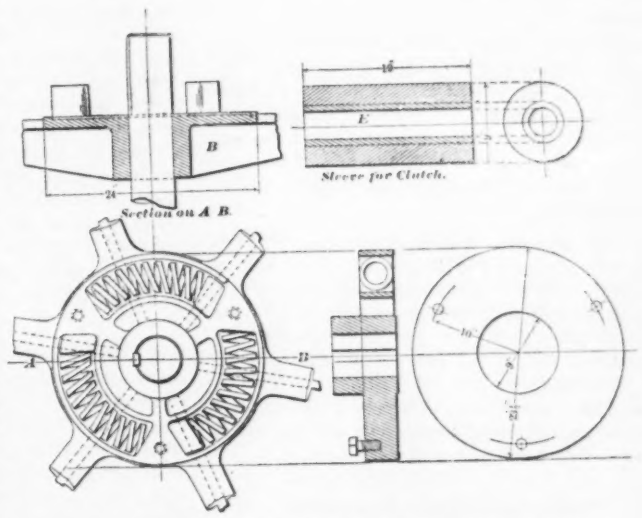


FIG. 1. SPRING HUB FOR CABLE DRIVING GEAR WHEEL.

(Omitted from page 588.)

On the grounds adjoining pumping station No. 1 a large tent had been set up; and after the visitors had looked at the pumping machinery as much as they desired, they assembled in this tent and discussed a substantial meal which was there spread. Superintendent Edwin Darling, of the Pawtucket water-works, acted as Toast Master, and the guests were made welcome by the Mayor of Pawtucket. As the rain prevented the visits to the Pawtucket manufactories which had been planned, the luncheon was followed by speeches by Hon. John Wyman, and Messrs. Holloway, Denton, Oberlin Smith, Daniel Ashworth and Secretary Hutton.

Before returning to the train the party assembled again in the pumping station, where the engine was entirely unloaded by opening a valve which permitted the water to discharge into the supply well; the increase in speed of the engine under this extreme test was hardly perceptible.

The return to Providence was made in quick time and the party then broke up, most of the members from New York and points West leaving on the evening boat.

In its social features it seems to be the general feeling that the convention was the most successful one ever held. A larger number of ladies were present than at any previous convention. A movement to hold the next summer meeting in San Francisco is making some progress; but as there are hardly a score of members west of the hundredth meridian, it would seem hardly wise to hold a meeting where so few members could attend, and where the busiest and most able members could certainly not be present. The choice of a place for next summer's convention is more likely to be between St. Louis and Detroit.

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COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—June 20. Secy., Howard Murphy, 1122 Girard St.

Western Society of Engineers.—July 1. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of St. Louis.—July 1. Secy., Arthur Thatcher, Room 801, Odd Fellows' building.

Engineers' Club of Minneapolis.—July 2. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—July 3. Secy., E. K. Smoot, 803 Commerce St.

Technical Society of the Pacific Coast.—July 4. Secy., O. von Geldern, 819 Market St., San Francisco.

Civil Engineers' Society of St. Paul.—July 6. Secy., C. L. Annan.

Civil Engineers' Association of Kansas.—July 8. Secy., J. C. Herring, Wichita, Kan.

Engineering Association of the South.—July 9. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Engineers' Club of Kansas City.—July 13. Rooms, Baird Building. Secy., H. Goldmark.

Atlanta Society of Civil Engineers.—July 14. Secy., Parker N. Black, 39 Capitol Block.

Civil Engineers' Club of Cleveland.—July 14. Secy., A. H. Porter, 50 Euclid Ave.

Boston Society of Civil Engineers.—July 15. Secy., S. E. Tinkham.

Engineers' Club of Cincinnati.—July 16. Secy., J. F. Wilson.

Engineers' Society of Western Pennsylvania.—July 21. Secy., J. H. Harlow, Pittsburg, Pa.

Denver Society of Civil Engineers.—July 23. "Canals and Irrigation." Secy., Geo. H. Angell.

In our article on "Wooden Water Mains," in the issue of June 13, we inadvertently gave the full credit for the device there illustrated to the author of the paper. Mr. HAWKS writes us that this is wrong; that the inventor is Mr. CHARLES W. DWELLE, of Denver, Colo., and that that gentleman holds letters patent for the same under date of Jan. 6, 1891. In justice to both Mr. HAWKS and the inventor we make this correction as conspicuous as possible.

THE late decision of the Attorney-General that all bridges over navigable streams can only hereafter be built under the direct sanction of the United States War Department, is likely to have important results, and will command widespread attention. The law is an old one and the Federal rights have always existed under the Constitution; but it has never, until now, been strictly enforced. Especially within corporate limits bridges have been built with no other authority than municipal sanction, and only upon such location and terms and under such supervision as to design and material as the conditions made with the local authorities might limit. As a rule, bridges of at least late construction have answered well enough their purpose as bridges; but whether or not full justice has always been done to those whose rights should have been considered, is another question. It has more than once happened that municipalities and railways and other interested corporations have combined in a bridge project that was directly opposed to the general shipping interests, and inland waters and harbors have been abridged to an extent that seriously interfered with such interests. The Attorney-General now holds that it is the duty of the War Department to pass judgment upon all such questions, and grant or withhold the privilege as that department may deem most just and equitable under all the existing conditions. The advantage of such a higher court is, that it will be removed from the charge of being influenced by local considerations, or by local deals between the contracting parties. There will doubtless be a vigorous kick against the enforcement of the late decision in many places; but recognized abuse under the old system makes it evident that this assertion of authority on the part of the government is only in the line of common justice to all men and to all interests.

SOME very astonishing figures for the mileage of car wheels in street-railway service were given last week in the paper by Mr. HENRY M. HOWE on "Manganese Steel." The average mileage of wheels from three different makers "on one of the most important street railways in this country" was given as follows: Wheels from "X," 7,748 miles; wheels from "Y," 16,373 miles; wheels from "Z," 4,539 miles. Two of these makers furnished cast-iron wheels, the other furnished steel wheels. Mr. HOWE explains the very small mileage by saying that the brakes are so often applied and so much sand and gritty matter lies on the rails that the tread is rapidly worn away. While this seems plausible, it is to be remembered, on the other hand, that the loads carried by each wheel and the wear in rounding curves are much less than in regular railway service.

But one fact is worth two explanations; and in contrast with Mr. HOWE's figures for wheel-wear we are able to present statistics from two other street railways which are as widely different from those above given as possible. One shows that two motor cars were in constant use for over three years, and made during that time 112,500 miles without changing wheels. The other states that two open cars without motors "have run three seasons, making about 81,000 miles each in that time, and show no signs of wear whatever now." The letters giving these reports were furnished to us at our request by Messrs. A. Whitney & Sons, of Philadelphia, and came to them unsolicited, in the ordinary course of business correspondence.

The difference between these mileage records and those given by Mr. HOWE is very great; so great that we hope some of our readers will favor us with some further records of wheel-mileage in street-car service. If a cast-iron wheel is worn out by running only 4,000 to 8,000 miles under a street car, as Mr. HOWE's figures indicate, there is great need of a more durable wheel. If, on the other hand, such a wheel can make over 100,000 miles before wearing out, as our figures seem to show, then certainly no wheel can compare with the cast-iron wheel, for the question of safety does not come in, as in regular railway service.

IN another column we publish an abstract of the report of the Committee on Testing-Laboratories of the Master Mechanics' Association. The committee make out a very good case in favor of testing-laboratories from the strictly technical point of view; but they might have said much more in favor of the testing laboratory as a bulwark against leaks in the railway treasury and then not have done justice to the case. It seems to be the case, however, that railway men outside the mechanical department, and railway stockholders generally, have little knowledge of or respect for the test department. Its results are not apparent to the ordinary observer; and it comes in contact with the general public less, perhaps, than any other department of the service. To give an example—an extreme one, we hope—of the low estimate placed by some men on the test department's work, we quote the following from a recent issue of the Omaha *Bee:*

"The move to abolish the test department of the Union Pacific system is the best one which the GOULD management has made," remarked a gentleman who keeps a close watch of the affairs of the Union Pacific road. "The department was a pet scheme of ADAMS. . . . . He reasoned about this way: 'The Pennsylvania has a test department and the Union Pacific must have one.' The difference in the wealth of the two systems did not seem to strike h'm at all. The Pennsylvania line has a large test department at Altoona. . . . . It is an expensive affair, but a wealthy road can afford it.

"Such a department is all well enough in its way, but it is not a necessary feature by any means. No other Western road has such an accessory, and the Union Pacific will get along just as well without it. If any mechanic cannot tell, with reasonable accuracy, what he wants, and don't know when he gets it, his services might will be dispensed with. I'll venture to say that any mechanic would tell the difference between silver and lead."

Another gentleman, in speaking of this matter, observed, "This analyzing of supplies is all fudge. No contractor who has an eye to business is going to furnish inferior supplies, which will result in his losing a contract. If the adulteration is so slight that it cannot be detected, I don't see what harm is done."

DOUBTLESS no argument is necessary to show the readers of ENGINEERING NEWS the transparent sophistry and absurd misstatement of facts in the above quotation. But a word or two as to the office of a test department in preventing one important class of losses to the railway company may not be amiss. When there is no test department to determine what qualities are necessary in paints, oils, metals, fuels and other supplies, and to see that the supplies furnished are up to the specifications, this work becomes too often everybody's business, which means nobody's business. Some system may be followed in specifying for and testing a few things; but for many or perhaps most supplies, entire reliance is placed on the manufacturer's reputation. Now this gives a direct incentive to a sort of dishonesty which is so common that it is not always recognized as dishonesty; we refer to the purchase of goods for other reasons than their cheapness or excellence. It is natural that the purchasing agent or other officer who relies on the manufacturer's reputation in purchasing goods should consider the manufacturer with whom he has a personal friendship, or possibly a family relationship, as the one of best reputation; and, of course, a good price must be paid for goods bought of a firm of high character! A man needs to have great strength of character and a very clear appreciation of right and wrong to resist this temptation in its every form, especially if he feels, as many men in the railway service have reason to feel, that he is being underpaid for his services by the railway company. Unfortunately, not every man occupying a position of authority in the railway service

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(we will say nothing about other corporations) is blessed with firm moral principles; and the officer whose conscience does not trouble him has frequent opportunities to make money by favoring this firm or that dealer, or helping this or that patent device into the service.

It is in preventing leaks of this sort in a railway treasury that the test department is especially valuable. A standard of quality is set up to which all those furnishing supplies must conform. The chance no longer exists for a profitable juggling game between the phrase "manufacturer's reputation for quality of goods" and "manufacturer's reputation for generosity"; for the manufacturer's reputation is no longer the main reliance.

Of course there is the possibility of direct bribery in the test department, or of pressure being exerted by high officials whose interests are more for their own pockets than for the railway's stockholders; but it is little more than a possibility, for it involves a far greater breach of trust on the part of men better able to resist temptation than in the cases described above. If these facts were better appreciated by railway stockholders, test departments of some sort would be the rule instead of the exception, on all railways whose business is large enough to warrant their establishment.

In an editorial on "What an Engineer Should Be," our London contemporary, *The Engineer*, very properly points out that pure animal courage, nerve, pluck, not moral courage, is one of the endowments essential to success in this profession. This is a personal characteristic not usually recognized in summing up the career of an engineer, who has made his mark in the world, but that our contemporay is right every member of the profession will admit from the evidence of his own experience or that of his fellow engineers. As a profession, engineering, in this respect, can be best compared with the calling of the soldier or sailor, in whose life events continually occur that demand the extreme of personal pluck, readiness of resource and that determination and tact that make a man a leader among men, and compel obedience. An engineer may theoretically know how to meet an emergency, and in his office figure out all the details of his plan and feel assured of successful results. But if he cannot meet this emergency on the spot and if necessary lead his men under conditions that may sometimes mean death to all concerned, his theoretical knowledge and finished training are practically of no avail, and the man lacks that essential something that means the difference between failure and success. No timid, hesitating man can ever be a great engineer.

Another essential in the personality of an engineer not commented upon by our contemporary is tact, or the natural instinct for reading character, and adapting words and actions to circumstances, and thus knowing how to deal with men. Many a good man otherwise has failed to attain success simply because he was constantly, but unintentionally, at odds with his masters or his servants. While many another man with comparatively little other help than his own shrewdness in reading men, and the faculty of pleasing those above and below him, has accomplished honorable results. In these comparisons on a basis of personality it is assumed, of course, that other things are fairly equal; but it is safe to say that the quick, bright young man, who is popular with his superiors, and is obeyed by his subordinates for his own sake, will outstrip in the race for preferment the ploding student who holds himself aloof from his associates on all sides and simply strives to do his duty and no more. As a very general rule, the successful engineer is also popular as a man.

In treating of the difficulty met with by parents in selecting a career for their sons, *The Engineer* closes the editorial referred to with the very level-headed advice—"to take little or no thought for the special proclivities of the youth, but put him into that branch of the profession in which you have the most interest." This will hardly accord with the views of some parents, who in their pride feel assured that their boy is "smart" enough to make his way anywhere; and assume that because the hair of the house can make a crude sketch of a locomotive, for example—usually with the smoke flying the wrong way—that he is destined by nature to improve upon all past practice in this line and to astonish the world as a mechanical engineer. Influence is just as powerful in the engineering profession as in politics; and the young man is not wise who abandons a field in which he can command the aid and backing of older and influential men, for one which he must till alone. He may succeed in the latter, and many do; but the average young man advances faster when he has some one to help him.

The Minimum Width of Ship Canals.

Ship canals, as a rule, demand at some place or other on their line one or more deep cuttings through dividing ridges of mountains or hills, and the volume of excavation represented by these cuttings usually forms a very important item in the total cost of construction; on the Nicaragua Canal the Atlantic divide cut alone, for example, amounts to 22% of the aggregate cost of that whole canal. Under these circumstances considerations of economy require that the surface width of the canal at these points, and consequently the volume of material to be removed, be reduced to the least dimensions consistent with a due regard for the purposes of such a canal.

In this connection the proposed 80-ft. surface width adopted for certain sections of the Nicaragua Canal has been criticised as being too narrow for the accommodation of all traffic, and as being likely to very much reduce the speed, to destroy steering power and to endanger ships making the transit of the canal. These criticisms are best met by stating the actual conditions on this canal, and then comparing the dimensions used there with the dimensions of other ship canals and the experience in working these other canals.

We elsewhere show in this issue the dimensions proposed for the various sections of the Nicaragua Canal. The minimum sections of 80 ft. in width with vertical sides occur in the 2.9 miles of the Atlantic divide cut, and extend over a length of 4.9 miles through the Pacific divide. At other points a bottom width of 80 ft. is adopted, with a top or surface width of 184 ft., and 30 ft. is the depth of water proposed for all of these comparatively narrow sections. Taking the lengths of these sections alone, we find that they are 2.9, 1.2, 4.9, 2.5 and 1.6 miles long respectively, and that they are widely separated, and in each case are contiguous to stretches of wide canals or to basins of very ample width for all passing purposes. The total length of this minimum width is therefore 13.1 miles out of 169 5 miles of "canal," counting from ocean to ocean.

It might also be said that the plans for the Nicaragua Canal call for a berm of 5 ft. on each side of the 80-ft. sections, with vertical sides, so that in case of any future demand by unanticipated volume of traffic the 80 ft. can be increased to 90 ft. at a comparatively small expense.

As to other canals, the Suez was originally built with a bottom width of 72 ft., a surface width of 325 ft. and a depth of 26 ft. The very flat slopes which this section gave to the canal were made necessary by the mud and sand through which it was excavated. This width of 72 ft. met all the requirements of traffic from 1869, the date of completion, to 1882; but in the latter year it was determined to make the canal deeper and wider to meet the increased demands of traffic, and this work is yet in progress. The improvement was demanded because the passing points for large vessels were located at considerable intervals apart, and made by simply widening the canal for a certain length on one side. Nothing but small vessels could pass in the canal proper; the sides slipped out and shoaled the channel, and the sudden expansion of the waterway at the passing points, or *gares*, injuriously affected the steering of vessels entering these stations, as will be later referred to.

The Corinth Canal, now under construction in Greece, and intended to connect the Gulf of Corinth with the Gulf of Egina, has a surface width of 75 ft. at the bottom of a cut 259 ft. deep. The proposed depth of water is 26.2 ft. The Panama Canal, on the "sea level" project as originally commenced, had a width of 78½ ft. at the bottom of the 333-ft. Culebra cut. And the "typical section" proposed in the later changes to a "lock canal" has a bottom width of 22 m., or 72.16 ft. The large lock on the Sault Ste. Marie Canal is 515 ft. long and 80 ft. wide, with 16 ft. draft of water. This is a very short length, of course, to use in a comparison of ship canals; but within the last month vessels of 3,000 tons have safely passed through this lock in from 19 to 20 minutes, counting from the time of entering to the time of leaving the dock.

The canals quoted include about all the channels comparable with the Nicaragua Canal, and from the data given it will be seen that Engineer MENOCAL has adopted the maximum section under the conditions described, and has made provisions for a greater section still.

In designing a ship canal, some standard must be first adopted for the maximum dimensions of the ships to pass through it, in beam, length and dratt of water. It is at once evident that this standard will very materially affect the volume of work to be performed, and therefore the ultimate cost. In fixing upon the dimensions of the "improved" Suez Canal, the engineers took a vessel of 45 ft. beam and 456 ft. in length as their standard and planned the new work of enlargement accordingly. It is true that ships of greater beam and length exist, but they are comparatively so few in number that it would be worse than absurd to expend the additional millions the larger standard would have demanded. It would be about as wise as to have taken the *Great Eastern*, a few years ago, as a model for the capacity of dock, harbors, canals and other marine engineering works. Ship canals are supposed to be commercially valuable as well as useful, and their true purpose is to accommodate the greatest volume of traffic at the lowest rate of toll consistent with fixed charges and the cost of operation. The heavier the original outlay and daily maintenance account the greater must be the toll paid by users of the canal, and these tolls can be made so excessive by a blunder of the kind above indicated as to drive traffic some other way.

The behavior of steam vessels in narrow and deep channels, of the kind described, is by no means a matter of guesswork; though Suez and the Sault Ste. Marie canals furnish the most instructive lessons in this particular. It should be said, however, at the start, that the straight-away transit of a single vessel of large size through an 80-ft. channel in rock is one thing; and the passing of two large vessels in even a much wider channel is a problem of an entirely different nature. Consequently, the narrow sections of the Nicaragua Canal, referred to, are planned for the passage of one vessel at a time of about the same standard in size as is used for this purpose on the Suez Canal. The speed assumed for a ship of this type is 5 miles per hour, and from the experience at the other canals this is not deemed excessive. With this speed, the longest stretch, 4.9 miles, would be equivalent to about one hour in the transit of a large ship, and even if another ship of equal ton-

nage had to wait before passing through this section in the other direction the time thus lost would not be a serious item in the total time of transit.

In steering a large ship through one of these 80 ft. channels, it should be remembered that tidal currents do not enter into the problem, as they do at Suez, and would have done in a very marked degree in the original plans for the Panama canal. In Nicaragua the tides are shut off at both ends by the locks; and at the Pacific end, where they are the highest, or 8 ft. in range, they only reach about one-half mile of the canal. The only currents practically affecting the transit of ships would be those due to an excessive flood in the San Juan River; but with ample waste weirs and the large basins acting as equalizers, these would give very little or no trouble. At Suez the tidal influence extends up about 12 miles from the Red Sea entrance, and amounts to about 3 knots per hour at its maximum. Naval officers advise that badly-steering vessels should never attempt to run with this current, for if they do they will surely run aground.

From the logbooks of a number of United States war vessels passing through the Suez Canal, and published by the Navy Department, we can learn something of the behavior of ships in channels of this description. The first one noted is the U. S. S. *Tennessee*, 4,840 tons, 365 ft. long and 46 ft. beam, which passed through the canal at an average speed of 5.3 knots per hour, the maximum speed permitted. The depth of water in the canal was 26 ft., and the draft of the ship was 20½ ft. forward and 22½ ft. aft. The only precaution taken with the steering apparatus was to see that the wheelropes were very taut, so that the ship might answer her helm immediately. The ship stopped three times at *gares*, to allow other vessels to pass, spent one night in Lake Timsah, and was 16½ hours in actual motion. The floor of this canal is 72 ft. wide, and the outer edge of this floor, or the foot of the long, flat slopes, is marked by buoys, between which the vessel must steer. The superficial breadth of the canal from Port Said to the anchorage at Suez varied from 90 ft. to 200 ft., dependent on the character of the cross-section as controlled by the height of the banks. At 13 points in the 99.9 miles of the length of this canal there are *gares*, or passing points, aggregating in length 1¼ miles, and with a floor three times the ordinary canal width and excavated out of one side of the canal only.

Lieut.-Commander C. F. GOODRICH, U. S. N., then commanding the *Tennessee*, reports that the ship "steered admirably," and never once touched the ground while under way. Just so long as the channel was of a uniform width the vessel steered steadily and "without the use of a rudder"; in other words, it sought and stuck to the mid-channel. This is readily understood, because, if the course is straight, the reflex pressure from the banks is equal on both sides. But when the canal was suddenly enlarged to three times its normal width, wholly on one side, as at these *gares* on the Suez Canal, the pressure varied, being greater on the side of least extent of deep water. In other words, the resistance is less on the side of greatest water surface, and in the case mentioned it was found that the *Tennessee* would slip out into the *gare* bodily and head directly for the transverse bank which made the end of the passing station.

The log-books of the U. S. S. *Alert* show exactly the same conditions, excepting that Commander MARVIN said that at the "stations" the ship's stern had a tendency to swing out into the wider water and sheer her bows into the bank, and that when another vessel passed "her suck" put an undue strain on the lines of the vessel which is tied up. Commander SAMPSON, of the U. S. S. *Swatara*, makes a note of special interest in connection with the steaming through narrow channels. He says he was surprised to find that the power requisite to drive his ship at a speed of 5½ knots through the Suez Canal would have been sufficient to develop a speed of 7 to 7½ knots in the open sea. He found that the surplus energy was expended in piling up the water in advance of his vessel, and that the difference in water level between bow and stern was sometimes several inches. This was due, of course, to the ship occupying so considerable a portion of the cross-section of the canal so as to interfere with the free passage aft of the water displaced by her advance. As Commander SAMPSON says, the speed developed will depend upon the relation between the size of the ship passing and the cross-section of the canal; and it is for this reason that Chief Engineer MENOCAL has used 5 knots per hour through these narrow sections of canal in figuring out the time of transit.

In the enlargement of the Suez Canal and the practical removal of the separate passing stations, the board of engineers decided that the floor of the canal should be 230 ft. wide to permit ships of 45 feet beam to safely pass each other at a speed of 6½ knots instead of 5 knots, and there should be a clear space of two ships' beams between the vessels and at least 25 feet between the outer sides of each vessel and the lines of buoys marking the limits of the deep channel. They are also deepening the channel to 27 ft. and contemplate an increase finally to 30 ft. in depth.

This new section for the Suez Canal is very great as compared with an 80-ft. channel, but it must be remembered that the conditions at Suez and Nicaragua are very unlike. In the first case a canal 100 miles long was excavated almost throughout on the narrow width, with passing points at intervals that, as shown, materially interfered with the use of the canal by their evil effects upon the steering qualities of ships and by the frequent delays under heavy traffic at the "stations." The long, almost continuous, length of narrow channel practically reduced the maximum speed to less than an average of 5 knots per hour, when the delay at stations was taken into account. The depth of water in this channel was originally 26 ft. instead of the 30 ft. proposed in the 80-ft. channel under discussion, thus still further reducing the section.

The proposed Nicaragua Canal, on the other hand, has in its total length of 169.5 miles 121 miles of natural water way, and a length of 21.6 miles in artificial basins of very ample width. The narrow sections, as before stated, are short and occur at considerable intervals apart and at points of deep rock cutting that would call for an unwise expenditure of capital in attempting to widen them, an expenditure uncalled for by the very conditions of the case. In estimating the total time of transit through the canal, the engineers adopt the following reasonable rates of speed:

At 5	miles	per hour	through	26	miles of canal.
At 7	"	"	"	21.6	" basins.
At 8	"	"	"	64.5	" river.
At 10	"	"	"	56.5	" lake.

In the above estimate of canal length there are only about 13 miles of the 80 ft. width; the other 13 miles have a width of 120 ft. on the bottom and 210 to 288 ft. on the surface, which is large enough for average vessels to readily pass each other. With these rates of speed, the total time of transit across Nicaragua, allowing 45 minutes' detention at each lock, is 28 hours. This gives an average speed of 6.5 miles per hour from ocean to ocean, or the maximum speed adopted for the new Suez Canal.

In summing up this evidence, in connection with the proposed 80 ft.-width in narrow sections of the Nicaragua Canal, it would seem, then, that Engineer MENOCAL has slightly exceeded the maximum width in deep rock cuttings on other ship canals, and has provided for a still greater width. It is also shown that while large ships cannot pass each other in these sections, they are so short and so arranged that there need be no practical delay in operating the canal. The experience at Suez demonstrates that ships steer themselves in these straight, narrow channels, and though fenders are provided for in the plans, there is little or no danger of the ship touching the sides at all. And finally, the average rate of speed in the Nicaragua Canal, from ocean to ocean, would be the same as is now being provided for in the latest improvement of the Suez Canal at an expenditure of many millions and after the experience of 20 years' active service.

Some Methods of Meeting the Ordinary Requirements of Railway Maintenance.

(*Concluded from page 561.*)

In the matter already given reference has been made to the necessity for "carrying" spans during repairs and rebuilding masonry, and a few of the commoner plans for doing this with different forms of truss are given herewith. The plan shown in Fig. 23 for pin-connected spans is applicable to any form of truss; but the support of each, or every other, or every third floor beam by a bent under its connection with stringers is often preferable if the floor beams have a riveted connection at ends. Fig. 24 shows a good method to carry a pin span, but is not applicable to a lattice span. Fig. 25 shows about the only desirable way to carry a triple-system lattice span. It is advisable to have the best foundation under the bent nearest the end of the span, where more than one is used, since settlement of the other bents would distort the span less than settlement of this one. If pin-trusses are to be carried at one end only, attention is called to the necessity for looking into the question of strains resulting from this support, and possibly introducing symmetrical supports at or near the other end of the span, to provide for the shifting of the center of the span. The same statement may of course be made as to lattice trusses; but the forms of iron used being such as to carry a certain amount of compressive strain safely, the necessity for making this support symmetrical with such spans is less common than with pin spans. Plate girders may of course be carried under any stiffener near enough to its ends to keep the strains induced in the overhanging part or cantilever from exceeding that allowable over the point of temporary support.

The platform of ties loaded with rails to obtain a bearing for a bent on soft bottom, shown in Fig. 23, is often of value.

Attention may be called in this connection to the preference which should always be given to square over skewed ends in all kinds of spans, the deflection of the long truss of the skew at a point opposite to the support of the short truss often being perceptible in a train, and resulting in a species of blow and recoil which is not allowed for in calculation and which is certainly detrimental to the trusses, while adding to the possibility of derailment. It is difficult also to maintain ties in good surface with one end on a skewed back wall and the other end on iron; and for these reasons a square end to a floor of a through bridge is very desirable, as well as at the ends of a plate girder or deck span, some of the modifications of design of iron and masonry needed to secure this being shown in Fig. 26. At least one serious accident within the past few years was due to neglect of this precaution.

The use of rails for short openings is recommended instead of timber stringers, because a large amount of labor by bridge repairers is saved thereby, and danger of fire is also avoided. This generally originates on such spans, and on all trestles, from cinders dropped from locomotives catching in the air space necessarily left between stringers of timber. These girders are also very stable and are obtainable at short notice.

Your attention is called to Fig. 27, showing forms in which old rails can be used to advantage in short openings, and to Fig. 28, showing a common and effective form of floors at the ends of bridges to prevent derailment, and, in case of derailment, to prevent ties from "bunching" and causing wreck, this being the most common cause of trouble in bridges without such provision. It is thought that with this provision and with ties spaced 6 ins. or less in the clear, there is little danger of derailment. It is also thought that the constant change in the height of rails, and the danger of suddenly replacing trains by rerailers, or of stopping them by bumpers, renders other provision of doubtful value.

[We entirely dissent from these remarks as to rerailing guards, and the opinions expressed are not, so far as we know, supported by a particle of experimental evidence. Dozens of instances are on record where these rerailing guards have saved trains and placed them safely on the rails. There is not one which has yet been revealed to the public where the "sudden replacing" or the "constant change in the height of rails" has made any trouble. The human mind is fertile in devising reasons for not having "done those things that we ought to have done," but before putting them in cold print, and especially before laying them down before the young for their instruction, it is not unreasonable to ask that something in the nature

of experimental evidence in support thereof should be advanced to establish them, not to say evidence of greater weight than the great mass which already exists in favor of those devices. Similarly the bridge floor shown, while better than a good many which exist, no doubt, is by no means up even to the general average of the most careful recent practice. Ties spaced 6 ins. apart in the clear are little better than a deathtrap if a derailed train strikes them, and the saving on a 2-in.. or 3-in. spacing is so trifling that there seems to be little excuse for the wider spacing. It is not generally realized, but is the fact, that the shock in jumping over the ties is very nearly as the *cube* of the clear space between them, and this shock is to a large extent cumulative, so that a spacing which might do very well on a short structure becomes extremely dangerous on a long one. The guard-railing and the end plan of Fig. 28 seem also inadequate.—ED.]

Fig. 29 indicates a method which has been used with success to prevent a sliding or quicksand slope in a cut from overwhelming or moving a track out of line. The slant of the ties spiked together gives them a strong hold upon a triangle of earth beneath the track; and the upper surface of these ties furnishes a convenient shelf from which to shovel the sliding clay into cars until its angle of repose is reached. This has been known to succeed when piling and walls of masonry have failed.

It has been observed that the "sloughing" of the slopes of such cuts can often be prevented by excavating them to a line almost half way out, and leaving a vertical face. Then when it "sloughs" the overlying earth covers the clay, as shown in Fig. 30, and protects it.

These few remarks are submitted only as indicating a few points in engineering work which occur in the course of ordinary track maintenance, and are, of course, outside the field of long spans and deep foundations, which seem to be best covered by monographs and reports made from time to time to the Societies of Engineers or published in engineering periodicals.

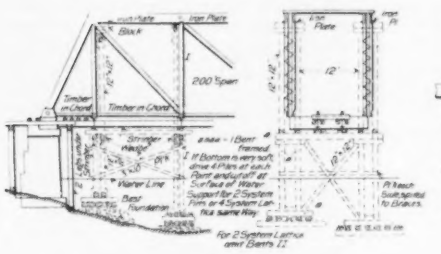


Fig. 23.

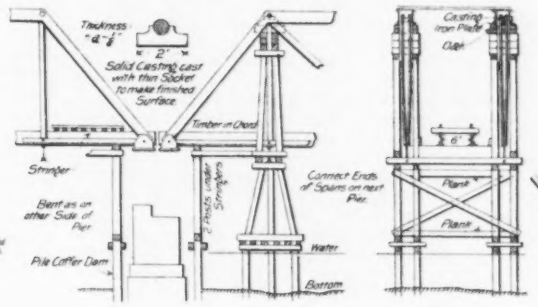


Fig. 24.

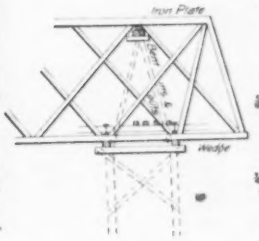


Fig. 25.

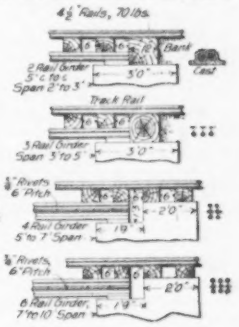
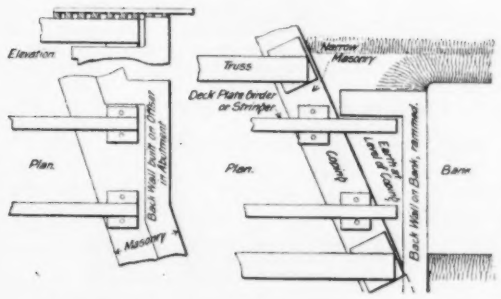


Fig. 27.



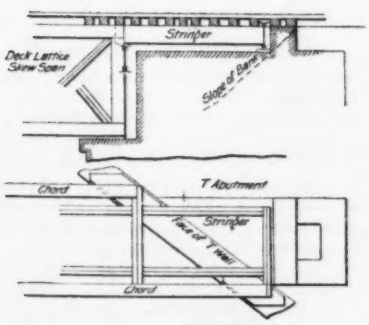


Fig. 26.

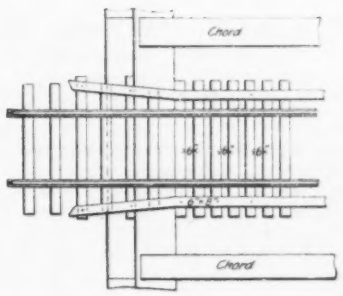


Fig. 28.

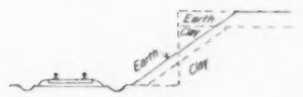


Fig. 30.

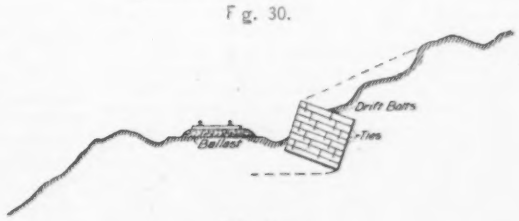


Fig. 29.

Specifications for Masonry.

First Class.—Piers shall be of sound stone from a layer and quarry approved by the Engineer of the Ry. Co. It shall be inspected at the cutting yard and at the work and may be rejected at either of these points, or, if injured in handling, after it has been laid, unless accepted by the Engineer in charge. It shall be free from vertical seams and shall have a rock or quarry face with not more than 2 ins. projection beyond planes of faces of masonry, and all horizontal surfaces of copings shall be axed or bushed. Surfaces of ice breakers shall be pointed smooth and all arris lines shall be defined by a chisel draft one inch wide. All corner stones and all those in ice breakers shall be clamped with iron clamps, ¾in. diameter by 18 ins. long, with 4-in. spurs to those next to them.

Copings shall be not less than 14 ins. thick and shall be clamped throughout. No stone below the coping shall be less than 12 ins. thick and no course shall be thicker than any course below it. All stone shall be laid in courses and shall be cut with half-inch joints or less. No vertical joint shall break less than 9 ins. At least one-third of the face of each course shall be of headers, properly placed to bond with stretchers in the courses above and below it. No header in any course less than 18 ins. high shall be less than 18 ins. wide, and in courses more than 18 ins. high no header shall be less in width than in height. No header shall be less than 3 ft. or less than twice its height in length.

No stretcher in a course less than 18 ins in height shall be less than 2 ft. in length, and in courses more than 18 ins. high, no stretcher shall be less in length than 1½ times its height. No stretcher shall be less than 2 ft. or than its height in depth. All joints and top and bottom beds shall be dressed square with each other, the vertical joints for at least 6 ins. and the beds at least 12 ins. from the face.

All quantities shall be estimated between face lines with no allowance for "rock" face.

All backing shall be of the same quality of stone, or as good, as the face stones, and shall be laid in courses with the latter, and either bedded thoroughly in mortar, or thoroughly grouted, as the engineer may direct. The stone used in backing shall be large, well proportioned stone.

All stone, both face and backing, shall be laid on its natural bed. All stone must be cleaned and wet before laying. All mortar used shall be made of one part fresh Rosendale cement to two parts of clean, sharp, screened sand, mixed dry; and no mortar which has been mixed more than one hour shall be used. All grout shall be thoroughly mixed with the same quality of cement and sand as those prescribed for mortar, and with equal parts of each.

All stone must be carefully bedded and then settled to the proper height and leveled by driving with a wooden pounder.

No drilling or cutting on stone in place will be allowed, except trimming clamp seats.

The work intended to come under this head is that in isolated piers only. No extra allowance for clamps used as above specified will be made.

All joints in face of masonry shall be thoroughly raked out and hollow pointed, with mortar consisting of one part of cement to one part of sharp screened sand.

Second Class.—Abutments and Arches.—This class of work shall be the same in all particulars as that falling under the head of first-class masonry, except that where it rests upon the natural ground or is surrounded upon all sides by the latter, the foundation or footing courses of thickness shown in drawing furnished bys the Ry. Co. may be built of large undressed stone with joints not more than ¾ in. thick on faces and ends of abutments, well bonded and carefully laid in mortar as specified. The stone in such foundation courses must be laid on quarry beds, and all irregularities of bed hammered to a good general surface. No spalls will be accepted in the face of such foundations or outside of the lines of the neat work. The specifications for first-class masonry, in respect to mortar and quality of stone, shall apply to all such foundation masonry, as well as to all other masonry falling under the head of second-class masonry.

In arched bridges, all wing walls and parapets will be built under the above specifications for abutments: and all sheeting shall consist of well bonded stone of the quality above specified and of a depth not less in any case than that shown on the drawings furnished by the Ry. Co.'s engineer. No stone shall be used in sheeting less than 8 ins. thick and 24 ins. long on line of axis of arch. All joints in sheeting shall break at least 6 ins., and soffits shall be axed or bushed.

Proper centering shall be furnished by the contractor without extra charge. No soffit joint shall exceed ½ in. in thickness. All joints shall be filled with mortar composed of one part Mellen's, or Saylor's American, or English Portland cement, and two parts clean, sharp, screened sand, with spalls of suitable shape and size imbedded therein and driven firmly into place.

After completion of the arch it shall be thoroughly backed and covered with a layer not less than one inch thick of Rosendale cement mortar, mixed as specified. All joints shall be thoroughly cleaned and pointed, and the embankment made in equal horizontal layers for at least 25 ft. on each side of abutments. All sheeting shall be dressed for at least 6 ins. back from the soffit.

Third Class.—Box Culverts.—This must be built of large stones, not less than 6 ins. thick, flat, and well bedded and laid dry. The curbs at ends and parapets shall be of good hammer-dressed rubble, laid in mortar, coped with stones of uniform thickness on each wall, each stone extending the entire width of wall. This coping to be hammer-dressed on top and bottom beds, and square on faces and joints. The covering shall be not less than 12 ins. thick for 2-ft. clear openings, and shall rest on the walls for at least 12 ins. For 3-ft. and 4 ft. openings it must be at least 18 ins. thick, and in openings of all widths shall rest at least 12 ins. on walls. All dry masonry shall be included in this class. During work on all masonry free passage must be maintained for water, traffic, or cattle, as the nature of its location may require.

Testing-Laboratories for Railways *

The committee states at some length the reasons for the establishment of testing-laboratories. Heads of railway departments are too much engaged with routine business to have time to keep up with current advances in engineering and chemistry. The chief of a test department must be somewhat versed in both physical and chemical science.

He should have had broad experience, and be able to generalize from the reports of his subordinates in such a shape that his statements will relieve his superior officers from the necessity of going into details. He must be able to plan methods of testing and experimenting, and see that they are properly carried out. He should not be looked upon as an adjunct of any one department in the road, but all should draw upon him alike in problems falling in his province.

WORK DONE BY A TESTING-LABORATORY.

A list of the subjects which can, in our opinion, be profitably undertaken embraces: First, routine work, physical and chemical, testing shipments of material kept in stock regularly and brought under definite requirements; second, special work, such as tests of the efficiency of machines, fuels, improvements in mechanical construction and patented devices (whether conducted on the road in actual trial or in laboratory), trials of water purification, tie-preservation methods and others.

In the field of "special work" are embraced those subjects which admit of professional opinion without actual experiment, and for such the experts connected with the department draw upon their knowledge of the engineering practice of the day. In order to be in a position to supply such advice, the head of the department must be a hard student of engineering literature, have a library, and, if possible, some regular hours of leisure to consult it. This seems to be a theoretical condition which, it is hardly necessary to say, does not generally obtain in the profession of railroading to-day.

The first aim in framing specifications should be to obtain completely the requisite standard for quality, neither more nor less, and in so doing to encroach as little as possible upon the freedom of the purchasing department in obtaining as wide a market as practicable to buy in.

* Abstracted from the report of the Committee of the American Railway Master Mechanics' Association, presented at the annual meeting at Cape May, N. J.

Having found the qualities of importance from a service point of view, these must be brought out by laboratory tests of such a nature that they can be duplicated under exact conditions each time, and be quick, handy and cheap.

A standard specification should in no sense be considered final, but must be subject to alteration from time to time as the market supply varies and as service reveals weak points.

In receiving materials bought under specifications, samples must be taken representing a certain definite percentage of shipment, and acceptance made subject to behavior of sample under test.

The relations between the purchasing and testing departments should be close and cordial, each recognizing in the other the labor-saving advantages of their work and pulling together for the benefit of the road.

DO TESTING DEPARTMENTS INCREASE COST OF SUPPLIES?

Our inquiries among a considerable number of the larger and better class of manufacturers, many of whom themselves pursue systematic methods of testing, lead us to believe that they are very much in favor of railway test departments properly conducted; one reason being the protection given them against unprincipled dealers by putting all upon the same level.

Your committee believes, after careful inquiry and considerable experience, that the cost of supplies may be very slightly increased through the work of the department; but not to an appreciable extent, nor to that which at first might be expected.

Among the tendencies toward lowering the cost are:

1. Manufacturers have, when selling to meet specifications, definite knowledge of how the quality of their material will be ascertained by the purchaser, and they do not therefore have to make allowances for uncertainties in this respect.

2. The cost of material is not proportionately increased with a bettering of the quality on account of the constant effort of manufacturers to meet demands for improved qualities by introducing cheaper processes.

3. In many instances much less costly material is bought under specifications than under the old practice, where fancy prices have been paid for material which was above the necessary requirements in quality and yet was formerly justified because uncertainty was not permissible.

The only well-defined tendency toward increasing cost is in establishing a perfectly reliable standard of quality. The magnitude of this tendency will of course vary with different roads, and can only be considered for each case separately. It will be conceded that a certain standard or quality is necessary for safety; and a well-organized department establishes only this necessary grade. On the score of safety to life and property, therefore, the results to be obtained in this way from a testing-department would seem to constitute one of its most valid claims to our consideration. Another of the benefits—and not the least—conferred upon the railway world by the establishment of testing laboratories is that through them manufacturers have become better acquainted with the requirements of railway practice and have been brought to modify their methods to meet our requirements, and that with the least increase of cost consistent with the requisite quality. A close watch from year to year upon the variations in the character of material received through a testing-laboratory gives convincing testimony to the truth of this statement.

FORCE REQUIRED.

The physical and chemical work should be in charge, respectively, of a specialist who may be called the "engineer of tests" and the "chemist"; these men should report to a general head of the department, the superintendent, who may be related to the other officers in the operating department in a manner which is deemed locally advisable, but should be freely at the disposal of all departments to whom his work is of use.

The numerical force of a fully equipped department on one of the larger systems of the country may comprise:

One superintendent, one chemist and one assistant, one foreman of test room and two assistants, two general assistants to the superintendent for special experimental work and inspection of material at a distance. A portion of the force in each branch may usually be young men who have had good technical educations, and who are willing to spend some time in the laboratory for the practical training they will get, and at a nominal salary. In fact, the testing-laboratory provides a very valuable school for training young men for usefulness in other departments.

EQUIPMENT AND COST OF A TESTING LABORATORY.

The requisites for a testing laboratory are sufficient room and light, water and gas for the chemical and power for the physical laboratory. In designing the chemical laboratory, the best, though not absolutely essential, arrangement should provide separate apartments for various classes of manipulations. A moderately costly plan would embody a general or main laboratory of about 500 sq. ft. area, containing hoods for fume work, evaporating baths, sinks and work-benches, the whole piped conveniently for water, gas and steam; an oil testing room of 100 sq. ft., with fireproof floor and hood; a balance-room and office of 240 sq. ft., a photometric and photographic darkroom of 150 sq. ft., and a storeroom of 100 sq. ft., or a floor space in all of 1,100 sq. ft.—say 22 × 50 ft.

The cost of the equipment for such a laboratory will be about $1,150.

The physical laboratory may comprise a general test-room of 800 sq. ft. area and a small office of 180 sq. ft. area. The testroom must contain power shafting, either from main engine of shops or from a special motor, for running machines, and a vise and work bench. The least amount of equipment considered by your committee satisfactory is as follows:

A 200,000-lb. screw-power vertical tensile testing machine, arranged to take tensile specimens up to 4 ft in length and transverse and compression tests of any desired length; a screw power machine of same type as the above, of 50,000 lbs. capacity, to be used in light work where the heavy parts of the larger machine impair accuracy and consume time in handling; a hydraulic spring-testing machine of 60,000 lbs. capacity, with registering apparatus, scale-beam for weighing stress, and weighted arm to test quality of motion, when desired; an axle drop-testing machine arranged for testing axles and springs; a car-wheel drop-testing machine. A friction oil-testing machine would be a valuable adjunct, if one could be had which would give results under conditions comparable with those of practice, or even results under certain ideal conditions, if these results could be always duplicated by different observers at different times; your committee know no machine on the market which properly fulfills these conditions.

For the miscellaneous outfit is needed a set of U. S. Standard male and female gages, both screw and bank, up to 2 ins. diameter, a set of staybolt tap gages, a vernier micrometer gage for taking sections, and a set of scales and machinists' tools. For special work of an experimental character, a varied equipment would be needed, suited to the circumstances; this equipment would embody a steam-engine indicator and rigging, apparatus for boiler tests, dynamometer car, etc. The cost of apparatus for a physical laboratory would be, according to the above list, about $4,650.

In addition to the equipment and room above provided for, the superintendent of the department should have an office, which, besides the usual fittings, should contain a cabinet for storing specimens of various materials and parts of machines which have shown abnormal results in practice or defects in structure; also a good working library of scientific and technical books and periodicals.

A Contrivance for Removing Anchor Ice at Chicago, Ill.

We are indebted to Mr. BERNHARD FEIND, First Assistant City Engineer of Chicago, for the following description of the contrivance for removing anchor ice, in use at the Lake View Water-Works at the foot of Sulzer St., Chicago.

The pumps are fed by four wrought-iron intake pipes of different lengths and diameters, laid along the bottom of the lake and provided at the lake end with intakes of different constructions. The largest

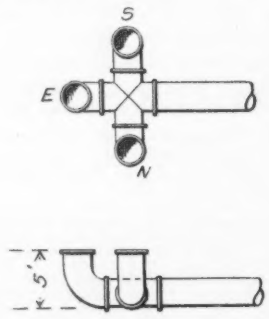


Fig. 1.

pipe, 30 ins. in diameter and 900 ft. long, with riveted seams and flange and bolt joints, and a ball and socket joint every 50 ft., has three intakes consisting of pipe set vertically and joined to the main pipe by a cross and elbows. Each of the three apertures is flanged and carries a strong arched brass screen held by bolts with hooked ends. The general arrangement of these intake ends is shown by Fig. 1; the brass screen and the blow pipe, mentioned below, by Fig. 3.

A 1¼ in. wrought-iron blow pipe is strung along the 30-ft. intake pipe by means of double eyes, one eye being slipped over a flange bolt between the flange and nut, and the other eye carrying the blow pipe. This blow pipe is carried around the circumferences of the eastern and the northern intakes. The shore end of the blow pipe is connected with the receiver of a Rand compressed-air rock-drilling plant employed in the construction, through rock, of the 6-ft. circular brick water-tunnel two miles long, which is to take the place of the wrought-iron intake pipes.

The terminal circle-bends of the blow pipe, Fig. 2, are perforated in such a way as to let the compressed air escape under and across the screens, lifting any anchor ice or other solids adhering to the latter. In

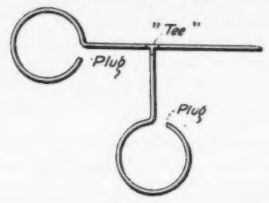
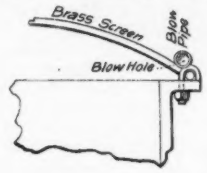


Fig. 2.

calm water the mechanical effect of the escaping and expanding air is seen in a "spout" over the intake 12 to 18 ins. high, and even when the lake is very rough the action of the blow pipe can be plainly seen from shore.

The contrivance has been used with success during the latter part of the cold season. Once on a very cold morning such a solid mass of anchor ice had attached itself to the intakes that the compressed air was at first unable to tear it off and found vent through a leak in the blow pipe about half way out, but when part of the heavy mass had been dislodged by means of hooks handled by men in a boat, the compressed air did the rest as well as ever before. The leaks have since been repaired. In very cold weather the blow pipe might have to be



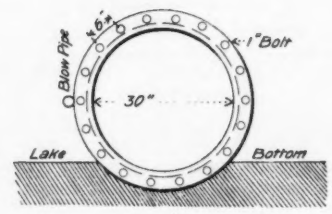


Fig. 3.

kept in action continually. The contrivance must be pronounced a success, provided the blow pipe is kept free from leaks.

The mechanical effect of the compressed air escaping with such velocity seems to neutralize and overcome entirely the injurious thermic effect produced by the great fall in temperature in exhausting the compressed air. The pressure commonly used in operating the pneumatic rock drill is 40 to 50 lbs. in the receiver.

Car Lubrication.

A book on this subject is soon to be issued from the press of John Wiley & Sons. The author, Mr. WILLIS E. HALL, Asst. Master Mechanic, Pennsylvania R. R., at Altoona, Pa., is a member of the American Society of Mechanical Engineers. His paper on the electric motor as a competitor of the locomotive, read at that meeting, will be remembered by every one present at that meeting for the warm discussion it aroused.

Through the courtesy of the publishers we are enabled to present the following extracts from advance proofs of the opening chapters:

The subject of car lubrication is wholly dependent upon the conditions which influence friction. There is hardly any other one branch of railroad engineering where the heretofore accepted laws of friction are at such variance with practice.

The widely taught law that friction is independent of the extent of surface in contact, but varies only with the pressure, is about ready to be placed among the archives

of ancient scientists. The extent of surface in contact was supposed to have no effect upon the force or work of friction necessary to move one body upon another.

Recent investigations upon the friction of lubricated surfaces, made with the object of determining the laws governing the coefficient of friction with various grades of lubricants, have shown the contrary to be more like the true conditions than those previously stated. If the relationship of the "resistance of friction as independent of the area of surfaces in contact, but dependent upon the pressure," were true, the temptation would be to reduce the work of friction and the abrasion of the materials by an increase of the length and diameter of the journal.

Practical demonstration, however, has proved the necessity of avoiding long journals; while, with the friction of rotation, an increase in the diameter of the journal means a corresponding increase in the work of friction. These investigations indicate, and quite conclusively, that friction is, when the rubbing surfaces are kept well separated by the lubricant, more dependent upon the nature and fluidity of the lubricant than upon the nature of the solids carrying the load.

As the resistance of lubricated surfaces is made up of the resistance of the particles of the lubricant, it is evident that any influence that will change its fluidity will also affect the frictional resistance. Increase of temperature, increasing the fluidity, causes a decrease in the coefficient of friction; while increase in unit pressure causes an increase in the density of the fluid, and, necessarily, an increase in the friction when motion is produced.

The condition to be attained is that where the viscosity of the oil is such at the working temperature that it will be sufficient to keep the solids from contact under the pressure which must be sustained.

The convincing point which should be kept in mind is the fact that frictional resistance and the abrasion of the surfaces is a representation of an expenditure of money, and of an amount greater than is generally supposed. The object of the following chapters will be, pure and simple, to reduce the conditions to a relationship the nature of which will assist toward reducing this expenditure, either directly or indirectly, to the lowest attainable figure.

When the bearing is first placed upon the journal the arc of contact is small. It will be found that the greatest amount of the pressure is taken at the top of the journal, and decreases in a determinable ratio from that to the horizontal axis through the centre of the journal. The work of friction is then but a question of the space which is passed over against the frictional resistance which is offered to the rotation. The space in this case is a function of the circumference, and varies as the diameter of the journal.

The law of the distribution of the pressure is as follows:
Let (see Fig. 1):

P = unit vertical pressure;
P_1 = unit pressure in a radial direction;
R = radius of the journal;
ω = angle made by the radius from a point O with a vertical line through the centre of the journal.
l = length of bearing,
L = total load carried.

For any point, O,

$$P_1 = P \cos \omega.$$

The pressure upon a surface $Rd\omega$ is

$$P_1 l R d\omega.$$

The summation of the pressure should be for an equal arc on each side of the vertical, or

$$L = \int^{x} P_1 l R d\omega; \text{ and by inserting the value of } P_1.$$

$$L = \int^{x} P l R \cos \omega \, d\omega.$$

From this, the load carried by various arcs subtended can readily be obtained. The accompanying table will indicate the values for several values of ω. It will also allow a comparison of the value of the pressure upon a 20° arc for higher values of ω.

Value of ω	Average pressure carried per sq. in.	Sq. ins. of surface when radius equals unity.	Percentage carried by first 20° of the arc.
10°	0.34729	0.1745	100.00
20°	0.68404	0.349	51.78
30°	1.00000	0.5235	34.74
40°	1.28558	0.6980	27.01
50°	1.53209	0.8725	22.67

It is then evident that most of the pressure is taken by a small arc of the journal, and that the lower surface of the arc of contact figures as a much less important part of the distributing surface for the load. It would then appear that if the bearing had a surface contact of 3.5 ins. when the journal is 4 ins in diameter, there would be very little cause of trouble arising from too high a unit pressure. It would also follow that the practice of boring out the bearing to a greater radius than the journal is open to no serious objection, providing the difference in the radii is not made too great. When this is done a condition similar to that shown in Fig. 2 results. The sharp corners at A have a tendency to scrape the oil from the journal, and in that way give trouble. This effect will be more apparent farther on. The condition shown in Fig. 2 will result in very poor lubrication, and is likely to produce a heated journal. In practice it is found that good results are obtained when the bearing radius is about $\frac{1}{32}$ in. more than the radius of the journal. This gives a safe working margin for a new bearing and journal. The difference in the radii becomes greater when a new bearing is placed upon a worn journal. The detrimental effect which arises with too large a difference between the arcs of the two parts is overcome by lining the bearing with a soft metal of about $\frac{1}{16}$ in. thickness.

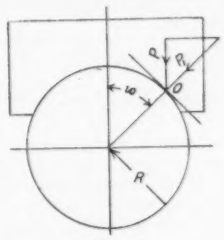


Fig. 1.

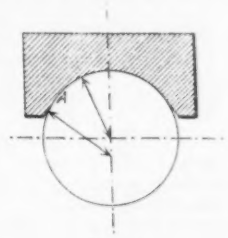


Fig. 2.

COEFFICIENT OF FRICTION.

We will assume, first, that the lubricant in all cases prevents any contact of the metal surfaces. The condition then stands between the laws of solid friction on the one hand—friction independent of the surfaces in contact, but dependent upon the total pressure—and the laws of friction of liquids on the other—that friction is independent of the pressure per unit of surface, but is directly dependent upon the extent of surface and increases as the square of the velocity. From most recent investigation this intermediate condition has been found to be, when stated in a general way, that the coefficient of friction decreases with an increase of the pressure, although the total resistance rises directly but not proportionately with the higher unit pressures, and increases with the velocity, although not as rapidly as its square. It is also found to be dependent upon the extent of surface in contact. An exact relation between these varying conditions has not yet been obtained, evidently because they vary so materially with any slight variation in the method used of lubricating the surfaces. As, for instance, when the oil bath is used, the laws of lubricated surfaces, especially as regards surface and pressure, follow those of liquid friction very closely; while, with less efficient means of lubrication, the results give a more intermediate result between solid and liquid friction. This matter will be brought out more prominently in the chapter on the methods of lubrication.

With the surfaces in good condition and the oil-bath method of supplying the oil, which may be considered as practically perfect lubrication, it was found that the mean resistance per square inch of surface with pressures varying from 100 to 310 lbs. per sq. in. was as follows:

Lubricant.	Mean resistance in lbs.
Sperm oil	0.484
Rape oil	0.512
Mineral oil	0.623
Lard oil	0.652
Olive oil	0 654
Mineral grease	1.048

[Results obtained by Tower.—See *Engineering* for Nov. 16, 1883, and Feb. 6, 1885.]

The speed was 300 revolutions per minute, and journal 4 ins. diameter and 6 ins. long, while the temperature was maintained at 90° Fahr.

A constant temperature is essential for a proper comparison, as in one case with lard oil the coefficient of friction decreased to one-third ($\frac{1}{3}$) its value at 60° by an increase to 120° Fahr. in the temperature of the lubricant.

A Cairo Street at the World's Fair.

What promises to be one of the most interesting and novel features at the coming World's Fair will be a Cairo street, lined with reproductions of some of the most famed buildings of that city and peopled by Egyptians engaged in various industries. This exhibit, it is said, will far exceed in extent and variety, the "Cairo Quarter" that was so popular at the Paris Exposition of 1889. The architect is Mr. MAX HERZ, who is an official of the Egyptian Government, as the architect-in-chief of Arab art, and is widely known for his intimate knowledge of all that pertains to Moorish and Arabic architecture.

His plans are models of artistic beauty, and show a mosque of the 15th century, dwellings for rich citizens of the 16th century, a minaret and other buildings of a similar character modeled after ancient or existing structures. The 50,000 sq. ft. to be occupied will include Arab coffee shops, restaurants, schools, shops, and manufactories of Arab products. In the streets will be about 100 donkeys and their drivers, Bedouins with their camels, Egyptian street venders, etc. It is proposed to bring over Egyptian policemen, with the permission of the authorities, and all is to be done that could convey a correct idea of Arab life in the Cairo of to-day. We regret that, for obvious reasons, we cannot reproduce the plans of some of the structures proposed by Mr. HERZ.

As Mr. HERZ himself holds an official position under the Egyptain Government, he could not personally see to the carrying out of his plans, though he has the permission of the government to engage in this work. But we understand that his place in Chicago will be well filled by Mr. HARRY IVES COBB, a well-known architect of wide experience and now one of the architects of the World's Fair, and the designer of the Fisheries Building for the fair. Mr. COBB has designed a number of fine buildings, including the Union Club, Opera House, Orwig's Building, Chicago Athletic Club House, Chicago University, and many other structures in that city. The Egyptian plans would certainly lose nothing by his interpretation of them.

Mr. GEORGE PANGALO, who is energetically at work promoting this enterprise, and who first introduced it to the attention of the World's Fair Directory as early as Jan. 30 of this year, is an Englishman, of Greek and English parentage. His grandfather was the English Consul General at Smyrna, and he himself was formerly the General Manager of the Cairo branch of the Anglo Egyptian Bank. He is personally known to the editors of this journal, one of whom met Mr. PANGALO in Cairo and Constantinople, and was in a position to know something of both his business and social relations. He is very active, thoroughly versed in the customs of the country which he here proposes to represent, speaks and writes seven languages, and seems generally to have the qualifications necessary for carrying this novel exhibit to a successful issue. He has had one or more audiences with the Khedive on this subject, who generally approves of his project; and he further has, we understand, all the capital needed, mainly subscribed by Chicago and New York capitalists.

Government Irrigation Experiments.

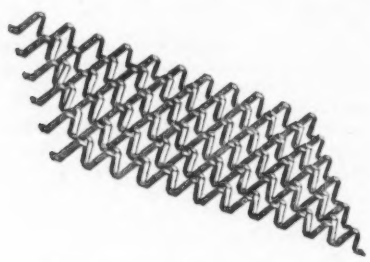
It has been already noted in these columns that experimental irrigation stations are to be carried on by the government in the Dakotas this year. The last Congress appropriated money to be expended in irrigation works in connection with some of the Indian reservations in the so-called arid region. Information regarding these appropriations and the proposed works has been given us by Mr. HERBERT M. WILSON, M. Am. Soc. C. E., who is connected with the U. S. Geological Survey, and has charge of some of the irrigation work mentioned above.

The sum of $200,000 has been appropriated to be expended in the construction of irrigation works on the Crow Indian Reservation in Montana. This money is immediately available. Mr. WALTER GRAVES, C. E., Denver, Col., has been appointed chief engineer of these works, and is now engaged on the surveys and plans for irrigating the lands adjacent to the Big Horn and the Little Big Horn. There has also been appropriated $30,000 for the purchase of pumping machinery and appliances, and for the construction of the necessary ditches and reservoirs for irrigating certain lands in Montana, Nevada and California. Recommendations have been made to various Indian agents in these states, requesting the expenditure of a portion of this money on their reservations. The Secretary of the Interior has decided not to sanction these expenditures without proper engineering advice, and has detailed Mr. WILSON to make examinations, and report on these projects, recommending the adoption of these plans or suggesting changes. This work is in progress.

Irrigation pumping machinery costing about $3,500 is to be purchased by the Government for use on the Mojave reservation. Water will be taken from the Colorado River. Recommendations for a similar operation have been made by the agent on the Colorado River reservation, and extensive projects have been suggested for parts of the Navajo reservation in Arizona and certain reservations in Nevada.

Botsford Surface Cattle Guard.

This cattle guard is made of longitudinal and transverse strips of bar iron, 1½ × ¼ ins., bent into the shape shown in the cut and riveted at the intersections. The longitudinal strips are 2½ ins. high, and the transverse strips 3 ins. high, the difference of ½-in. making an uneven footing for cattle. The guard is 8 ft. long, and is in three sections, one



Botsford Surface Cattle Guard.

between the rails and one, 20 ins. wide, on the outer side of each rail. No pit is required, the sections being fastened to the ties or to framed timbers. This guard is the invention of Mr. F. G. BOTSFORD, Superintendent of the Botsford Car-Heating Co., Cleveland, O.

The Boynton Bicycle Railway.

The bicycle or one-rail railway between Gravesend and Coney Island, N. Y., is now in operation and well repays a visit. The line is on a part of the old Sea Beach & Brighton Ry., and extends from a point near the Gravesend station on the New York & Sea Beach Ry. to the back of the beach on Coney Island, a distance of about 1¾ miles. The track is a single line of 72-lb. rails on the old roadbed, and the overhead wooden guide rail is supported by timber gallows frames, with posts on one side of the track. For new lines with heavier traffic iron ∩ frames will be used. The locomotive No. 1, with a single driving wheel 8 ft. diameter, cylinders 12 × 14 ins., and weighing 23 tons, has been found too heavy for this road. The engine now used is of type No. 2, with a vertical boiler having 102 tubes, cylinders 10×12 ins., a single driving wheel 6 ft. diameter under the tank and bunker, and two 42-in. wheels as a leading truck in front of the boiler. The working pressure is 130 lbs. per sq. in. The engine weighs about 9 tons empty, about 4½ to 5 tons being on the driving wheel, but the weight on this wheel is increased by the load of coal and water. The wheels have grooved tires. The tires on the truck wheels are 4¼ ins. wide, with grooves 2 ins. deep. A steam brake is fitted to the engine, applying a brake shoe on each side of the wheel. Above the cab is a frame carrying the two horizontal guide wheels, one on either side of the overhead guide rail, which keeps the engine upright. Engine No. 1 has deflectors above the smokestack to throw the steam and smoke away from the guide rail, but engine No. 2 is so high that the deflectors are inside the top of the smokestack. Both of these engines were built by the Portland Co., of Portland, Me. The later type of locomotive, now considered by the company as its standard, and known as type No. 3, is carried on two coupled driving wheels placed under the boiler. An engine of this type with cylinders 12 × 14 ins., and driving wheels 5 ft. diameter, will weigh about 16 tons. The cars in use on the Coney Island line are double deck, divided into 18 compartments, 9 on each deck. The compartments have two seats across the car, and are wide enough to carry 3 persons on each seat, making a total carrying capacity of 108 passengers. The cars weigh about 5 tons empty, and are carried upon two trucks similar to the engine truck, with 42-in. wheels. A brakeman rides on the rear platform, where are the brake wheel and four levers by which the brakeman can open and close simultaneously the doors on each side of each deck. The cars were built by the Amesbury Car Co., of Amesbury, Mass. The horizontal overhead guide wheels are faced with rubber, vulcanized to the iron wheel. Both engines and cars are very evenly balanced, and a man standing on a level with the upper deck of the cars can easily tilt the engine from side to side. When running, the engine tilts slightly from side to side, bringing one or other of the guide wheels to bear upon the guide rail, according to the effect of the curves or of any irregularities in the track. The motion is not sudden or jerky, however and does not therefore throw severe strains on the guide rail, while at intervals the engine will run for some distance without either of its guide wheels bearing on the overhead rail. The character of this motion was observed from the top of the tank.

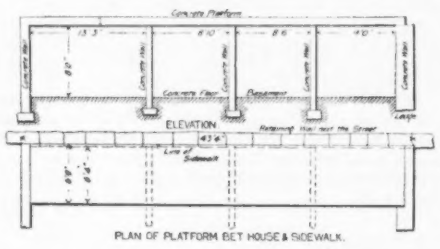
As noted last week a company has been organized to build a line across Long Island between Patchogue on the Atlantic side and Rocky Point on Long Island Sound, a distance of about 25 miles. Other lines are also projected. The Boynton bicycle railway system has been described and illustrated in ENGINEERING NEWS, March 2, 1889 (pp. 185 and 193), and Jan. 10, 1891. Any of our readers who are interested in the question of economical railways will do well to take the opportunity of seeing this interesting specimen of a one-rail railway in operation.

A Reinforced Concrete Platform.

In ENGINEERING NEWS of May 23 was given a description of the Monier arch of concrete stiffened with wire netting. A somewhat similar idea was employed in 1884 by Mr. PHINEHAS BALL, President of the Union Water Meter Co., of Worcester, Mass. He constructed a Portland cement concrete floor between the front of his residence and the sidewalk, of the dimensions shown on the accompanying cut. Next the street it rests on a retaining wall forming the street wall of the basement, which extends out under the floor and is there used for storage room.

The floor rests on 2 end and 3 partition walls, as shown in the cuts, where the clear space between the walls in each room is indicated. The clear width from the retaining street wall to the house is 6 ft. 4 ins., making the largest slab of concrete 13 ft. 3 ins. long by 6 ft. 4 ins. wide, clear of all supports.

The manner of building was as follows: The space to be roofed by this floor was covered by planks held



firmly by proper supports. On these planks the concrete slab was constructed in one piece and in place. The material used was Portland cement, sand and rubble slate stone. The cement and sand were mixed in the ratio of 2 of cement to 4 of sand, or 1 of cement to 2 of sand, in the same manner as for laying ordinary stone work.

The laying of the stone and cement was done entirely by hand. The stones are flat and thin, and usually of an area, resting on the beds, of not over 10 ins. square, and running down from that size to pieces not over 3 ins. square. They are not over 3 ins. thick. The floor is 9 ins. thick; 7 ins. is made of slate stone and mortar as above, and the 2 ins. of upper surface is made of clear cement and sand floated and troweled down as in making a sidewalk. The laying was done so as to fill all voids between the stones used and make a solid piece of concrete.

The work was also strengthened by ¼-in. iron rods, running lengthwise and over the walls about 3 ins. from the under side, and about 9 ins. apart. These rods were thus entirely buried in the concrete.

After the slabs had been allowed to harden for some time the supports were removed. The platform has stood remarkably well, and Mr. BALL writes as follows regarding its present appearance:

> The floor has stood the storms of some 8 winters, and to-day is as perfect as at first. There has never a crack appeared in any portion of it except a slight one on the surface, and it is perfectly water-tight. As viewed from the outside it appears like a marble slab, 43 ft. 4. ins. long and 6 ft. 9 ins. wide.

A NEW AUTOMATIC ELECTRIC BLOCK SIGNAL for railways was recently successfully tested at Dunkirk, N. Y. The signal is the invention of M. S. Conly, and consists in brief of a track instrument, a signal instrument, and the necessary wires, batteries, relays, etc., for operating them. The track instrument is inclosed in an iron case about 20 ins. long, and consists of an insulated toothed wheel connected in the electric circuit through two spring pawls, one of which is connected with a lever. This lever is operated by a shorter lever bearing upon a bracket fitted closely underneath the head of the rail. The passing train deflects the rail and operates the levers, causing the pawl to let go a notch in the wheel, thus momentarily breaking the electric circuit, and producing an induced current through the line wire and polarized relays which control the electro-magnet operating the signal disks in the towers. The signal towers contain the necessary batteries for supplying the electric current and the mechanism by which the disks are operated. The disks consist of a sheet of red gelatine between two sheets of mica. The line wire connecting the towers is inclosed in an insulated iron pipe one foot underneath the surface of the track. The signal is manufactured by the Martin Anti-Fire Car Heating Co., of Dunkirk.

THE FILTRATION OF THE WATER SUPPLY OF PHILADELPHIA is under consideration by the Council's Committee on Water. On June 10 representatives of 9 different filtering systems appeared before a sub-committee on filtration and submitted data. In a report upon the subject the committee describes briefly five systems in the following order, recommending the last: The Anderson, Morrison-Allen, Hyatt, National and the Municipal Water Improvement Co.'s systems. The last-named system seems to have been improvised for the occasion. It is vaguely described in the report as a "purely gravity system," and as combining "the best and generally recognized features which have been applied to the purification of water for years, namely, subsidence, coagulation, precipitation and filtration." The scheme provides for the filtration of the water supply at one plant, after which it would be distributed to the various pumping stations on the Schuylkill by gravity. Subsiding basins and filtering cylinders are both spoken of in this connection. The cost of maintaining the various systems per million gallons is given by the committee as follows, all the figures being for a 150,000,000-gall. plant, and the Hyatt representatives not caring to give figures on a single plant with a capacity of more than 15,000,000 galls.: Anderson, $1.50; Morrison-Allen, $2.50; National, $2.80; Municipal, 63 cts. The latter system, it is estimated, would cost $2,500,000 for the plant. It should be borne in mind that all these figures are deduced by the committee from the informal, as we understood it, hearing on the subject.

A NOVEL TYPE OF OBSERVATORY CAR has been devised by Mr. T. J. MCBRIDE, of Winnipeg, Manitoba. Three or four sections of the car roof are raised to a height of 12 to 18 ins. above the ordinary level, forming a sort of "conning tower," the sides of which are glazed. Second story seats are provided in these sections, where the passengers can sit and view the scenery in any direction. The ordinary use of the lower seats or berths is not interfered with, and the upper seats can be made up as berths, leaving more space to the lower berth occupants than in the ordinary car. The proposed innovation has some attractive features, but it is a question whether the added weight in the upper part of the car would affect its safety, and whether the considerable motion in swinging around curves or running over rough track would not make many travelers seasick. A car built on this plan, too, would require a very perfect system of heating and ventilation, or the passengers in the upper seats would find it very hot and stuffy. There is little doubt, however, that a system by which travelers could get a better chance to watch the passing scenery than the ordinary car or even the parlor car affords would be quite popular, especially on roads which pass through an attractive country.

ELEMENTS OF WEATHER IN THE UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF MAY, 1891.
[Furnished to ENGINEERING NEWS by the Chief Signal Officer, U. S. A.]

	Station.	Temperature, (Deg. Fah.) Average.	Max.	Min.	Range.	Wind. Velocity miles per hour. Average.	Maxim.	Direction at time of max. velocity.	Precipitation—Rain and melted snow. Inches. Total.	Heaviest in 24 hours.	Number of rainy days.
NORTHERN CITIES.	Northfield, Vt.	50.7	85	27	58	8.7	54	W	2.46	1.42	13
	Portland, Me.	49.8	57	42	15	7.7	39	SW	3.47	1.31	16
	New York City	59.9	84	38	46	11.6	38	NW	3.10	1.30	13
	Pittsburg, Pa.	58.8	84	34	50	4.9	24	S	3.23	0.96	10
	Chicago, Ill.	53.4	81	35	46	15.9	51	S	2.19	0.84	7
	Omaha, Neb.	59.4	83	38	45	8.6	45	NW	4.94	1.71	11
	St. Paul, Minn.	57.7	83	28	55	6.5	24	NW	1.33	0.90	7
	Duluth, Minn.	48.6	86	26	60	6.8	26	W	2.28	1.74	6
	Bismarck, N. Dak.	54.1	93	20	73	11.9	42	SE	2.92	1.16	6
	Average...	54.7	81.7	32	49.7	9.2	38.1	.....	2.87	1.26	9.9
SOUTHERN CITIES.	Washington City	61.0	89	38	51	7.0	26	NW	3.72	1.22	13
	Louisville, Ky.	63.4	84	38	46	6.0	31	N	1.56	0.64	12
	St. Louis, Mo.	63.6	89	42	47	10.0	36	SW	2.73	1.11	7
	Savannah, Ga.	70.6	91	50	41	7.0	39	NE	1.87	1.12	11
	Leavenworth, Kan.	...	...	...	...	...	...	...	...	...	...
	Jacksonville, Fla.	72.8	92	54	38	6.6	37	NW	2.78	1.36	10
	Chattanooga, Tenn.	67.5	90	42	48	5.0	25	N	1.29	0.53	9
	New Orleans, La.	73.8	89	53	36	8.0	33	SE	0.76	0.75	3
	Memphis, Tenn.	68.2	91	45	46	6.3	26	NW	1.75	1.28	4
	Palestine, Tex.	69.8	87	46	41	5.9	36	NE	1.67	0.93	6
	Average	67.8	89.1	45.3	43 8	6.8	31.4	.....	2.02	0.98	8.3
WESTERN CITIES.	Helena, Mont.	54.9	88	26	62	7.5	36	W	2.51	0.83	13
	Port Angeles, Wash.	50.6	70	33	37	3.2	15	SW	0.92	0.35	9
	San Francisco, Cal.	55.7	75	48	27	10.5	28	SW	1.02	0.61	5
	Salt Lake City, Utah	60 0	86	38	48	5.7	30	NW	0.72	0.36	12
	Denver, Col.	56.2	83	32	51	7.3	28	NW	4.15	2.02	12
	Yuma, Ariz.	74.2	100	54	46	7.0	36	NW	trace	trace	0
	Santa Fé, N. Mex.	52.9	74	30	44	7.4	30	SE	3.21	0.87	12
	Average	57.8	82 3	37.3	45.0	6.94	29.0	.....	1.79	1.00	9.0

THE MULTIPLE SPEED & TRACTION CO. is to be authorized to construct at once a short experimental line of this system in Jackson Park, at Chicago, with a view of testing its merits for the rapid transportation of large crowds. This is the device of Mr. M. E. SCHMIDT, described in ENGINEERING NEWS of Dec. 13, 1890, and has already been indorsed by some of the leading engineers of this country. The officers of the company are: A. P. GILMORE, President; O. CHANUTE and J. L. SILSBEE, Vice-Presidents; M. E. SCHMIDT, Secretary and General Manager, and F. W. GOOKIN, Treasurer.

THE AMERICAN STEEL BARGE CO. is about to send three of its 3,200-ton "whaleback" freight carriers around Cape Horn to Port Townsend, on the Pacific Coast. These boats are built at West Superior, Wis., and the first one has already been sent down the lakes and the River St. Lawrence to Montreal. This barge is first to take a general cargo from New York to Liverpool; and is then to again load at New York and bring an assorted cargo to San Francisco. It is claimed that they can steam at an average rate of 13 knots per hour, and they carry a crew of 22 to 26 men.

THE WOODBRIDGE WIRE-WOUND GUN is to be completed and tested. Work was begun on it two years ago and $2,818 has been allotted for its completion by the Fortifications Board. A sum has also been appropriated to survey sites for mortar batteries for the defense of San Francisco, and the Chief of Ordnance has been authorized to construct some of the new 12-in. rifles with a length of 40 calibres.

ACCORDING TO THE ENGLISH CENSUS of 1891, London has a population of 4,221,452, as compared with 3,816,483 in 1881. Liverpool comes next in population, with 517,116, and has 35,392 *fewer* inhabitants than in 1881. Manchester is third, with 506,409, an increase of 48% over the previous census. This is partly due to including a larger area in the later census. Birmingham has 429,906; Leeds, 369,099; Sheffield, 325,30 , and Bristol, 222,049. The remainder, in the list of "28 large towns," fall below these figures, and Wolverhampton, the last on the list, has a population of 82,600. The population of the 28 towns is 9,398,000, an increase of about 1,000,000 over the census of 1881. The rate of increase is thus about 12%, as compared with 16½% in 1871-81. Glasgow, in Scotland, has a population of 532,282, and is not included in the list of English towns given above.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Pennsylvania.—It is stated that work will commence at once upon the extension of the Cambria & Clearfield R. R., from Carson, Pa., to Cheat Creek.—The branch now being built from Kuylor's Station to coal fields in Cambria Co. will, it is stated, be extended to the Blacklick coal region in Indiana & Cambria counties. It is also stated that the line recently built along the Conemaugh River will be extended to connect with this line, and also to Johnstown, Pa.

Delaware, Lackawanna & Western.—The surveys have been completed for the proposed branch to Irvington, N. J., and it is probable that steps will soon be taken to build the line.

Boston & Albany.—This company has commenced work on its double tracking at Westfield and Pittsfield, Mass. About 66 miles of double track will be laid this year.

Maine Central.—This company will issue $900,000 of capital stock for the purpose of providing funds for double tracking a portion of its line, and for equipping new road acquired last year and making other improvements.

Philadelphia & Reading.—The Chestnut Hill & Jenkintown R. R. Co., has been chartered to build the 4-mile line from Glenside to Chestnut Hill, near Philadelphia, noted in our issue of June 13.

Waynesboro & Washington.—It is stated that surveys will soon begin for the extension of this road to Mannington, W. Va.

Dutchess County.—The ties are being shipped for this New York railway, and it is stated that tracklaying will begin soon.

Projects and Surveys.

Maine Shore Line.—At the annual meeting of the stockholders of this company, recently held, the following directors were elected: A. McNicol, S. D. Leavitt, J. N. Campbell, Wm. M. Nash, L. G. Downs, John K. Ames, Austin Harris, J. S. Clark and A. F. Kinsley.

Hunters' Run & Slate Belt.—Chartered in Pennsylvania to build a railway from Pine Grove furnace to Old Slate Quarry, 7 miles, all in Cumberland and Adams counties. President, Jackson C. Fuller, Philadelphia, a.

Long Island Boynton Bicycle.—This company has been chartered in New York to build a railway to be operated on the Boynton bicycle plan from Rocky Point to Great South Beach, Long Island. The length of the road will be about 20 miles and it is stated that work will begin at once.

Toledo & Western.—The charter and franchises of this Ohio railway company have, it is stated, been sold to a syndicate of Canadian and New York capitalists. The road was projected to run from Toledo, O., to Chicago, Ill., and it is rumored that the syndicate is purchasing the road in the interest of the Canadian Pacific Ry. Co.

Farmington & Kennebec.—This company has completed its organization by electing the following officers: President, John F. Hill, Augusta, Me.; Treasurer, A. M. Spear, Gardiner, Me.

South Chester.—Chartered in Pennsylvania to build a railway from Lumpkin Station to the Delaware State line near Marcus Hook, 4 miles. John P. Green, Philadelphia, Pa., President.

Delaware Terminal.—This company has organized with W. L. Sisman, Chairman, and John D. Hawkins, Secretary. It proposes to build a railway from Lewes to Clayton, Del.

Westerly & Jewett City.—The surveys for this road, from Westerly, R. I., to Jewett City, Conn., have been completed. The road will be 25 miles long, and will run through Ashaway, North Stonington, Valunton, Glasgo, Petrel, Pachange and Hopeville.

Lewiston, Augusta & Camden.—This company has been organized in Maine with the following officers: President, Elias Milliken; Directors, Elias Milliken, John W. Chase, George E. Macomber, John F. Hill, James W. North, P. O. Vickery, W. H. Williams; Treasurer, M. V. B. Chase; Clerk, F. E. Southard.

SOUTHERN.—Existing Roads

Danville & East Tennessee.—The contract for building the section from Bristol, Tenn., to Damascus, Va., 25 miles, has been awarded to J. B. Sullivan and C. R. Moorman, of Lynchburg, Va.

Kentucky Union.—Work on the three-mile extension necessary to complete this road to Jackson, Ky., is making good progress and the line will probably be completed by July 15.

Morristown & Cumberland Gap.—Tracklaying has been commenced on this road which is projected to run from Morristown to Carryton, Tenn., 44 miles. It is expected to have the road in operation by Sept. 1.

Norfolk & Western.—Track has been laid upon extensions of this road as follows since Jan. 1, 1891: Cold Grove, O., toward the Ohio River, 5.6 miles; Kenova, W. Va., toward Elkhorn, W. Va., 20.45 miles; Elkhorn toward Kenova, 11.4 miles, and 8 7 miles on the extension to Norton, Va.

Lynchburg & Durham.—At a recent meeting of the stockholders it was voted to issue bonds to provide for an extension from Durham, N. C., to the Raleigh & Gaston R. R. W. C. Houston, Jr., of Philadelphia, Pa., was elected President in the place of Peter J. Otey.

Fincastle & Troutville.—About 2¼ miles of the grading have been finished on this line from Fincastle to Troutville, Va., 6¾ miles. It is stated that surveys will soon begin for an extension from Fincastle to some point on the Chesapeake & Ohio R. R.

Projects and Surveys.

North Georgia.—This company has completed its organization by the election of E. B. Murray, of Anderson, S. C., President, and J. E. Broyil, of Anderson, S. C., Secretary. The road is projected to run from Anderson, S. C., to Franklin, N. C.

Arcadia, Gulf Coast & Lakeland.—Anthony Peters, of 88 Lincoln St., Boston Mass., is President of this recently incorporated company which proposes to build about 200 miles of standard gage railway in Southern Florida.

Archer & Dunnellon.—This road will be 34 miles long, running from Archer to Dunnellon, Fla. The gage will be 5 ft. 8½ in., and 56-lb. rails will be used. D. G. Ambler, Jacksonville, Fla.

Interstate Land & Construction Co.—Chartered in Florida by J. C. Davis, W. P. Dunham and others to build railways in Georgia and Florida.

Lynchburg, Keysville & Atlantic.—The Virginia Land & Improvement Co., of Keysville, Va., is interested in this project to build a railway from Lynchburg, Va., to Weldon, N. C., 115 miles.

Latta Tramway & Mill Co.—This company has commenced surveys for its proposed railway from Latta to Bennettsville, S. C.

Cincinnati & Kentucky Southern.—Chartered in Kentucky to build a railway from Yosemite to King's Mt. Among the incorporators are: H. D. Emerson, W. J. Perkins and Edward Ritchie.

Tavares & Atlantic.—This company asks $10,000 from the citizens along the route to aid in the construction of the proposed railway. Alex. St. Clair Abrams is President.

Charleston, Glendennin & Sutton.—This company has completed its organization by the election of F. W. Abney, President; J. B Floyd, Secretary; J. D. Barnes, Treasurer, and M. Jackson, J. B. Floyd and C. C. Lewis, Executive Committee. It proposes to build a railway from Charleston to Sutton, W. Va. About $50,000 has been subscribed in aid of the road.

Queen City Belt Line.—A railway company by this name will probably be chartered in Georgia. R. C. Johnson, W. A. Clark and others, of Gainesville, Ga., are interested.

Tredegar Mineral.—Chartered in Alabama to build an 8-mile belt railway at Tredyan, Ala. W. H. Forney, Jas. Crook and others, of Tredegar, Ala., are among the incorporators.

Statesville Air Line.—C. A. Carlton, of Statesville, N. C., writes us that this road is projected to run from Spartanburg, S. C., to Mt. Airy, N. C., 140 miles. J. J. Mott is President and W. A. Eleasen is Chief Engineer, both of Statesville.

Blacksburg.—Wm. H. Graham, of Blacksburg, Va., writes that nothing definite has been done by this com-

pany toward building its line, but that it is trying to make arrangements for connections with other projected roads entering Roanoke, Va. The right of way will be granted by the people along the route, and other local aid can probably be obtained. J. F. Christian, of Roanoke, Va., is President.

Arbuckle Creek & New River.—Chartered in West Virginia to build a railway from Rush Run to the Fork of Arbuckle, Fayette Co. J. W. St. Clair and J. H. Gaines, of Fayetteville, W. Va., are among the incoporators.

Staunton & West Augusta.—A correspondent writes us as follows:

E. C. Vincent, of Staunton, Va., Chief Engineer, is making a preliminary survey for a railway from Staunton, Va., via Churchville, Jennings Gap, Dor Hill and Osceola to Elkins, W. Va. The route as surveyed is very favorable and passes through a rich timber and mineral section of the country.

NORTWWEST.—Existing Roads.

Winona & Southwestern.—An official of this road is quoted as saying that the company had decided to build south to Omaha, Neb., instead of to Sioux City, Ia., as was first intended.

Canadian Pacific.—Tracklaying is reported commenced on the extension to the Souris coal fields.

Great Northern.—It is stated that the contract for building a cut-off from Hendrum, Minn., to Hillsboro, N. Dak., has been let to Oliver Dalrymple, of Grand Forks, N. Dak.

Dakota, Wyoming & Missouri River.—The contract for building 12 miles of this road west from Rapid City, S. Dak., has been let to Woods, Bancroft & Co., of Omaha, Neb. The road is projected further west to the Wyoming coal fields and east to the Missouri River. W. T. Coad, of Rapid City, S. Dak., is President.

Projects and Surveys.

Sioux City & Northwestern.—A correspondent writes us that this road is projected to run from Sioux City, Ia., via Hartington and Niobrara, Neb., to Rapid City, S Dak., 450 miles. About 170 miles have been located and the preliminary surveys finished for 300 miles. The maximum grade will be 1% and the maximum curve 3°. T. P. Gere, President; J. F. Duncombe, General Manager, and L. F. Wakefield, Chief Engineer, all of Sioux City, Ia.

Pueblo & Duluth.—It is stated that surveys will soon begin for this railway under the direction of L. F. Wakefield, of Sioux City, Ia.

Sioux City, Madison & Northern.—It is stated that the surveys have been completed from Madison to Garretson, S. Dak.

SOUTHWEST.—Existing Roads.

Texas Central.—A press dispatch states that a reconnoisance will be made soon for the following extensions of this road: Waco to Garrett, Tex.; Roberts to Paris, Tex.; Waco to Ross, Tex.; and Albany to Vernon or Washburn, Tex.

St. Louis & Hannibal.—The citizens along the route are endeavoring to secure the extension of this railway from Hannibal to Centre and Perry, Mo. They have promised to donate a roadbed ready for the track from New London to Perry, and are endeavoring to secure the right of way into the City of Hannibal. In case the latter is obtained the railway company promises to have the extension completed before winter.

Burlington & Missouri River.—It is stated that the Atchison & Nebraska R. R. has let the contract for building the 40 mile cut-off from Troy Junction to Preston, Neb.

Houston Belt & Magnolia Park.—It is probable that construction will soon begin on the 2-mile gap necessary to complete this road. There is also talk of extending the line to Harrisburg, Tex.

Missouri, Kansas & Texas.—This company is replacing wooden bridges along its lines with iron structures. Work is now in progress upon the Choctaw Division.

San Antonio & Aransas Pass.—The contract has been let to Mr. Flynn Kennedy for building the extension from Lexington to Lott, Tex. Work is to begin at once.

Fort Worth & Rio Grande.—About 10 miles of track have been laid from Comanche toward Brownwood, Tex. It is expected to have the road completed to Brownwood by July 16.

Projects and Surveys.

Arkansas.—A company has been organized to build a railway from Helena, Kan., to the mouth of the St. Francis, 10 miles.

Texas.—A project is on foot to build a railway from Bryan, Tex., to Lewis' Switch, on the International & Great Northern R. R. J. N. Henderson, of Bryan, Tex., is interested.——M. A. Bridges, of Bonham, Tex., contemplates building a dummy railway.——There is talk of building a railway from Navasota to Madisonville, Tex., 42 miles.

Sunnyside Co.—This company is building a railway from Sunnyside Landing, on the Mississippi River, west to a connection with the Louisiana, Kansas & Missouri R. R.

ROCKY MT. AND PACIFIC.—Existing Roads.

Port Townsend Southern.—This road has now been completed from Port Townsend to Quilicene, Wash., 27 miles.

Rio Grande Western.—It is stated here that this company has two surveying parties in the field, one in the San Joaquin Valley, Cal., and the other starting from Marysville, Utah, for the purpose of surveying a route for a line to San Francisco.

Northern Pacific.—Tracklaying has been completed from Olympia to Harlowe Junction, Wash., and the ballasting is nearly completed.——About 500 men are at work on the line from Chehalis to South Bend, Wash., 54 miles. Six miles of track have been laid and 16 miles are graded.

Vancouver, Klickitat & Yakima.—This railway, running from Vancouver, Wash., up the Lewis River about 13 miles, has been sold to New York capitalists who will extend it 50 miles. The contract for 10 miles will be let at once.

California & Nevada.—The grading on the two-mile extension from Wagoner's Station to Orinda Park is making good progress, and tracklaying will begin soon.

Projects and Surveys.

Pasadena & Mt. Wilson.—Chartered in California to build a railway in Los Angeles Co. Among the incorporators are: P. M. Green and A. C. Armstrong, of Pasadena, Cal.

Coos Bay, Roseburg & Eastern.—This company has made a proposition to build its proposed railway from Coos Bay to Roseburg, Ore., on condition that the citizens of Roseburg grant the right of way and subscribe $75,000 in its aid.

Mount Hood.—Chartered in Oregon to build a railway from East Portland to Pendleton, Ore. A. W. Power, Portland, Ore.

The Dalles, Dufur & Silkstone.—Chartered in Oregon to build a railway from The Dalles, Ore., via Dufur and Tygh Valley to the Fossil coal fields. Among the incorporators are: R. H. Norton, T. A. Hudson and T. H. Johnston.

Denver & Irondale.—M. S. Beal, of 32 Essex Building, Denver, Colo., Secretary, writes us that this road is projected to run from Denver, Colo., to the manufacturing suburb of Irondale, 10 miles northeast. The surveys will begin in about a month or six weeks. The work will be light. Wm. W. Porter is President.

Portland, Nehalem & Astoria.—A railway company by this name has been chartered in Oregon to build a railway from Hillsboro, Ore., to coal mines, a distance of 27 miles. Among the incorporators are: T. F. Osborn, Cortland and J. D. Merryman, of Hillsboro.

FOREIGN.

Colombia.—The United States of Colombia has granted a concession to a syndicate of New York and Boston capitalists for the construction of a railway from Carthagena to Calimar, a distance of 52 miles. The concession includes a grant of 400,000 acres of public lands. Among the persons interested are: Jas. C. Colgate and R. L. Edards, of New York City, and T. Jefferson Coolidge and J. Murray Forbes, of Boston.

Mexican Northern Pacific.—Work upon this line from Denning, N. Mex., south, is being delayed on account of difficulty with the customs officers in regard to the transportation of supplies across the international boundary. It is hoped to have arrangements completed shortly whereby there will be no further delay from this source. Division Engineer Martineau will soon begin relocating the division from Chihuahua to Gurrero, Mex., and work will begin as soon after as possible.

Monterey & Mexican Gulf.—This company has secured the concession for a railway across Mexico granted to Gen. Geronimo Trevino at the last Congress, and will build the line as an extension of its system. It will run from Trevino, formerly Venaditos, west via Sierra Mojada, Jiminez and Durango, to Mazatlan, on the Pacific coast. From Trevino to Tampico, on the Gulf coast, a line is already nearly completed by this company. It is stated that arrangements are completed for beginning work.

Tehuantepec Ry. & Ship Canal Co.—It is stated that Simon Stevens of New York City, the former president of this company, will submit a proposition to the United States and Mexican governments, whereby the two governments will be asked to guarantee the interest on $100,000,000 of 2% bonds to provide for the construction of the proposed ship railway across the isthmus of Tehuantepec. The surveys for this railway were made by Capt. J. B. Eads many years ago.

Mexico.—A concession has been granted to Juan Violante to build a railway from the City of Mexico to Coyoacan, a suburb. The road must be completed in two years.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are reported as probable in the following places: Atlanta, Ga., address the Consolidated Street Ry. Co.; Louisville, Ky., address the Louisville Ry. Co.; Columbia, Pa., address W. B. Given; Erie, Pa., address the Erie Electric Motor Co.; Waxahachie, Tex., address the Lake Street Ry. Co.; Pasadena, Fla., address T. S. C. Lowe; Houston, Tex., address the Houston City Street Ry. Co.; Memphis, Tenn., address E. F. Adams; Bonham, Tex.; Warren, O.; Murphysboro Ill.; Swansea, Col., address Wm. Haigh; Williamstown, Pa.; West Somerville, Mass., address Sprague & Hathaway.

Boston, Mass.—The Railroad Commissioners have granted permission to the West End Street Ry. Co. to issue $4,500,000 of additional capital stock for making improvements.

Asbury Park, N. J.—The power station of the Sea Shore Electric Ry. was destroyed by fire June 18; loss $50,000.

Reading, Pa.—The Reading City Passenger Ry. will, it is said, adopt electricity for motive power.

Pittsburg, Pa.—A local newspaper states that the Birmingham, Knoxville & Allentown Traction Co. will soon apply for incorporation. Among those interested are H. S. McKee, J. A. Chambers, M. A. Verner, E. A. Denniston and J. F. Eisley. The company will, it is said, act as a feeder to the Pittsburg & Birmingham Traction Co.

Baltimore, Md.—At a general meeting of the stockholders of the North Ave. Electric Ry. Co., held June 23, it was voted to increase the capital stock from $50,000 to $100,000. The following officers were elected: President, W. H. Whitridge; Vice-President, J. Hilles; Secretary and Treasurer, L. N. Frederick; Directors, W. H. Whitridge, Dr. F. Slingluff, W. A. Moale, J. Hilles, F. K. Caren, E. G. Hight.

Anderson, Ind.—The Anderson Street Ry. has, it is said, been transferred to a local company which will extend it and introduce electricity.

Chicago, Ill.—A route for a line in the North Side has been surveyed by O. H. Knudson.

Bartlett, Mo.—It is reported that a company is to be organized to build a line to Cedar Rapids, a distance of 39 miles.

Waxahachie, Tex.—President E. H. Griffin, of the Lake Park Street Ry. Co., wants prices of a 50 H. P. generator and cars.

Spokane, Wash.—It is reported that a power house will be established at Spring Lake for operating a line between Spokane, Cheney and Medical Lake.

Toronto, Ont.—At a recent meeting of the County Council a motion was passed consenting to the granting of a charter to the York County Street Ry. Co., which proposes to build and operate an electric or steam line connecting with the present municipal railway.

Elevated Railway.—*Brooklyn, N. Y.*—The commissioners appointed to examine the application of the Sea Side & Brooklyn Bridge Elevated Ry. Co. for right to build a line to New Utrecht has reported in favor of the company.

Horse Railways.—Extensions are reported as probable at Brooklyn, N. Y., by the Brooklyn City R. R. Co., and at Milwaukee, Wis., by the Milwaukee City Ry. Co.

Boulder, Col.—The City Council has granted a franchise to Howze & Co. to build and operate a line. Work must begin within 40 days, a mile must be in operation within 90 days, and the entire system must be in operation within a year.

Cable Railway.—*Oakland, Cal.*—It is reported that the Consolidated Piedmont Cable Co. will change a part of its horse car lines to cable roads.

Dummy Railway.—*Salem, Ore.*—A number of residents here have appointed a committee to confer with the railway companies relative to building a 16-mile motor line to Silverton.

New Companies.—Pana (Ill.) Modern Electric Light Power & Street Ry. Co.; capital stock, $50,000; incorporators, J. W. Stokes, A. B. Corneau, J. Hirbin. Framingham & Ashland Street Ry. Co., South Framingham, Mass.; capital stock, $60,000; directors, W. B. Ferguson, of Malden; C. H. Emerson, W. H. Pratt, F. E. Gregory, of Framingham, and others. Grant Park Electric Ry. Co., Atlanta, Ga.; capital stock, $100,000; incorporators, H. L. and E. B. Woodward, J. H. Mountain. North End Street Ry. Co., Worcester, Mass.; capital stock, $.0,000; incorporators. G. F. Barnard, E. P. Curtis, O. A. Kelley. Morgan Park & Pullman Electric Street Ry. Co., Chicago, Ill.; capital stock, $250,000; incorporators, G. W. Todd, J. H. Westover, W. W. McDonald and others. Beaumont (Tex.) Street Ry. Co.; capital stock, $100,000; incorporators, E. P. Gegue, of Houston, and others. Leavenworth & Suburban Street Ry. Co., Leavenworth, Kan.; capital stock, $250,000; directors, G. A. Baker, W. Dill and others.

HIGHWAYS.

Maryland.—The Chestnut Summit Ave. Co. has been organized by James Boyce, Benjamin Payne and L. J. Roberts to build a road from Towson to Lutherville.

Tennessee.—A company has been organized at Knoxville to build a road 20 miles long.

Washington.—The Chamber of Commerce of Seattle has taken up the road question, and the issue of $500,000 in bonds has been proposed.

Ohio.—Contracts for pike roads have been awarded by J. B. Weddell, C. E., Galion, O., to J. B. Latham & Co., Lima, O., C. E. Clark, Kenton, O., and J. J. Lewis, Kenton O., at lump sums for labor and materials.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Lee, Mass.*—A stone arch bridge will be built to replace the old structure at Housatonic St.

Oswego, N. Y.—An iron bridge will be built to replace the wooden structure across the Owego River at this place. It will cost about $13,000.

Binghamton, N. Y.—There is a probability of an iron

bridge being built at this place to cross the tracks of the D., L. & W. and the N. Y., L. E. & W. railways.

Williamsett, Mass.—A highway bridge is to be built across the river, consisting of 4 truss spans of 170 ft. each, on masonry piers, and 2 plate girder shore spans of 51 ft. Edward S. Shaw, of Boston, Mass., is consulting engineer.

Pittsburg, Pa.—The Sixth Street Bridge Co. will replace its present bridge over the Allegheny River with a new structure to cost $500,000. Work is to begin about July 1.

Orange Grove, Md.—A bridge over the Patapsco River, to cost about $25,000, is talked of.

Indianapolis, Ind.—The County Commissioners have entered into an agreement with the property owners whereby a bridge will be built over Fall Creek at the Twenty-second St. crossing at this place.

Bay City, Mich.—Bids are wanted for an iron bridge across the Saginaw River at Twenty-third St.

Chicago, Ill.—The plans for the superstructure of the Ogden Boulevard viaduct are nearly completed, and bids will be asked soon. It will be a skew-bridge, 450 ft. long and 120 ft. wide. There will be two roadways 26 ft. wide each, and one 40 ft. wide, with 8-ft. sidewalks.

De Pere, Wis.—An iron bridge to cost about $16,000 will be built across the Fox River.

WATER-WORKS.

NEW ENGLAND.

Bradley, Me.—There is talk of granting a franchise to the Penobscot Water & Power Co., of Brewer, for an extension of its mains in connection with the same company's supply to Milford.

Laconia & Lake Village, N. H.—The company has voted to increase its capital stock $15,000 to raise money for extensions.

Penacook, N. H.—A meeting was to be held June 25 to discuss a supply from Walker Pond, to be brought through Boscawen Plain and Penacook. Estimated cost, $50,000.

Craftsburg, Vt.—A village meeting to raise money for works has been held.

Hardwick, Vt.—The following is from M. V. B. Hathaway, Village Clerk:

At a meeting held June 19 the Trustees were authorized to expend not more $10,000 for new works. The estimates include 12,400 ft. of 10 to 4-in. pipe and necessary hydrants. Joel Foster, Montpelier, is Engineer.

Rutland, Vt.—Flood & Sherrill, Sandy Hill, N.Y., have been awarded the contract for building the new 6,000,000-gall. reservoir, recently advertised in these columns, for $17,997. Chappell & Burke, Rutland, Vt., are Engineers.

Braintree, Mass.—Bids are wanted until July 1 for laying about 3 miles of 4 and 6-in. mains. Address Water Commissioners. W. Wheeler, 89 State St., Boston, Engineer.

Lawrence, Mass.—The Water Board has recommended the continued use of the present or Merrimack River supply and the adoption of a filtering plant at an estimated cost of $60,000.

Lowell, Mass.—A Morrisson-Allen filter is being tried at the expense of the company.

Malden, Mass.—The Council has voted to issue $20,000 of 4%, 20-year bonds to pay for land about Spot Pond. It is expected that Melrose and Medford will join with Malden and practically all the land about the pond be bought to protect the supply.

Milford, Mass.—A 2,000,000 gall. pump and two boilers will be added. Louis Hawes, 75 State St., Boston, is Engineer for the improvements.

East Hartford, Conn.—The fire district has appointed a Water Committee, of which E. O. Goodwin and J. J. Gleason are members, and has authorized the committee to contract with the East Hartford Water Co. for 40 hydrants at an annual rental of $30 each. P. S. Bryant, Hartford, is interested in the company.

Meriden, Conn.—It is reported that H. E. Stanton, of Huntington, has been awarded the contract for the new reservoir at $16,500. The lowest available bid for the pumping engine at the new reservoir was from the H. W. Lines Co., $8,400.

MIDDLE.

Afton, N. Y.—D. Van Woert informs us that the Village Trustees are talking of works. G. L. Church is Clerk.

Cooperstown, N. Y.—Village works at an estimated cost of $50,000 are projected. The company's works may be bought.

Whitestone, N. Y.—G. A. Roullier, Engineer, informs us that the village expects to let contract about Aug. 1 for works, including pump, stand-pipe and about six miles of mains.

Rutherford, N. J.—An ordinance granting a franchise to the Hackensack Water Co. has been passed over the Mayor's veto.

Bradford, Pa.—The Council has passed an ordinance providing for a new distributing reservoir.

Hughesville, Pa.—C. E. Albright, Engineer, Girard Building, Philadelphia, informs us that construction was started May 23, with Charles T. Gorman, Philadelphia, contractor. Contracts for pumps and boilers have not been let.

Oil City, Pa.—The Water Commissioners have recommended to the Council the construction of a reservoir at an estimated cost of $38,600. The plan is for two basins, each with a capacity of 3,700,000 galls.

Rouseville, Pa.—The Rouseville Water Co. has been incorporated to supply water for domestic purposes; capital, $2,500.

Union City, Pa.—J. C. McClean, Clerk, informs us that $15,000 of bonds will be issued for extending the works. Water will be filtered.

SOUTHERN.

Greenville, S. C.—The new works were recently tested.

Atlanta, Ga.—Bids for furnishing three large pumps are asked for in our advertising columns.

Cedartown, Ga.—Bonds for works have been voted.

Manchester, Tenn.—It is reported that J. H. Wolf, Evansville, Ind., has bought the private works here, and will add an engine.

NORTH CENTRAL.

Painesville, O.—It is reported that a new supply will be obtained from Lake Erie, which is three miles distant, the intake to be laid a mile into the lake.

Grand Rapids, Mich.—The pumping station of the Hydraulic Water Co. was burned June 19. Little damage was done to the pumps.

Mason City, Mich.—The people have voted, 481 to 83, in favor of $35,000 of bonds for works.

Port Huron, Mich.—It is stated that the plan for a tunnel beneath the Black River for water and gas mains has been given up, and that a new water main will probably be laid across the river at Seventh St.

Lincoln, Ill.—The Lincoln Water, Light & Power Co. has been incorporated to maintain water-works, electric street railway and lighting plants; capital, $250,000.

NORTHWESTERN.

Paullina, Ia.—Works are projected.

Rockford, Ia.—N. D. Bowles, Recorder, informs us that a contract for building works has been let to Fremont Turner.

Minneapolis, Minn.—Henry W. Phelps has applied for a franchise to lay mains in certain streets for supplying water for domestic purposes with but one faucet in a house, the water to be taken from Glenwood, Englewood and Fountain Springs and distributed through 6 in mains.

Oakland, Neb.—J. W. Holqiest, Clerk, informs us that works will be built by the town with S. K. Felton, Omaha, Engineer.

Armour, S. Dak.—It is reported that works will be built.

SOUTHWESTERN.

Carrollton, Mo.—It is reported that the company has increased its bonded debt from $25,000 to $50,000.

St Louis, Mo.—The sum of $87,000 has been asked for water service extensions.

Hope, Ark.—T. M. Battie, Clerk, informs us that extensive improvements are about to be made.

Milan, Tex.—Works are projected. Address the Mayor.

Guthrie, Ok. T.—A vote will be taken on the issuance of $55,000 of bonds for works.

Erie, Col.—Plans for works are being made. Bonds were reported as voted some weeks ago.

Raton, N. M.—The Raton Water-Works Co. has been incorporated by T. J. Pace, Russell Macy and others; capital, $75,000. Works were built here by a company in 1881.

PACIFIC.

South Bend, Wash.—A franchise was granted Seattle parties some weeks ago, but at last accounts it had not been accepted

East Portland, Ore.—The laying of mains in several streets is projected.

CANADA.

Toronto, Ont.—A committee of the Council is examining Lake Simcoe as a source of supply.

Pictou, N. S.—George D. Ives, Town Clerk, informs us that works are again under consideration. The Council are collecting information which will eventually be submitted to the tax payers.

ARTESIAN WELLS.

Pittsburg, Pa.—The contract for sinking five wells at Schenley Park has been awarded to L. J. Goehring at $1.35 per ft.

Beatrice, Neb.—Bids will be received by J. T. Phillips, City Clerk, until July 2, for a system of wells, with or without a guarantee, to furnish not less than 2,000,000 galls. daily.

Manchester, S. Dak.—Bonds for five wells under the Melville township law are proposed.

White Lake, S. Dak.—Bids are wanted until July 1 by A. H. Hall, Township Clerk, for drilling and casing, with wrought-iron pipe, four 6-in. artesian wells about 1,000 ft. deep. Six other wells are to be drilled in adjoining townships.

Dallas, Tex.—A well at the fair grounds is projected.

Itasca, Tex.—A contract has been let by the Council for a well 2,000 ft. deep, or less, as may be necessary.

IRRIGATION.

Fresno, Cal.—Press dispatches from this place state that the Sunset Irrigation District has voted to issue $2,000,000 for canals to lead water to lands on the west side.

Lassen Co., Cal.—Work has begun on the outlet to Eagle Lake, which has an area of 28,000 acres and an altitude of 5,000 ft. Land in the Honey Lake Valley will be irrigated.

Modesto, Cal.—The Turlock and Modesto Irrigation Districts have let contracts for building a joint dam to R. W. Gorrell, President of the Pacific Bridge Co., San Francisco. The dam will be built across the Tuolumne River, near La Grange. It will be of masonry, 105 ft. high, 320 ft. long at the top and 60 at the base, 20 feet thick at the top and 90 at the base. It is reported that it will be an overflow dam. The price is reported as $150,000 in cash and $1,000,000 in bonds at 90 cents on the dollar. $400,000 of the bonds to be of the Modesto and $600,000 of the Turlock District.

Perris, Cal.—J. W. Nance has sold to the Clear Valley Irrigation Co. 9,600 acres of land, near here, including the San Jacinto Nuevo lake or basin, for $90,000. It is reported that the company will build a dam 20 ft. high across the San Jacinto River and make other improvement costing in the aggregate $150,000.

Turlock, Cal.—Bids are wanted until July 7 for $50,000 of Turlock Irrigation District 6% bonds.

Yolo and Solano Cos., Cal.—The citizens of these counties talk of building a canal from Gray's Bend, on the Sacramento River, through the Montezuma Hills to Suisin Bay. The canal would carry off flood water and serve as an irrigating ditch.

Calabasas, Ariz.—The Santa Cruz Water Storage Co., it is reported, will soon begin construction. The first work projected is a reservoir south of this place.

New Companies.—Stuart Gulch & Phillipsburg Improvement Co., Phillipsburg Co., Phillipsburg, Mont.; $100,000; trustees, James K. Pardee, Herman and John Kaiser. Tijeras Water Co., Albuquerque, N. M.; $100,000; H. L. Warren, P. A. Simpson and others, of Albuquerque. Indian Creek Water Supply Co., Hood River, Ore.; $10,000. Weiser Artesian Water Co., Weiser, Ida.; $50,000; to deal in real estate, sink wells and construct ditches.

SEWERAGE AND MUNICIPAL.

Brick Paving.—*Dunkirk, N. Y.*—The city has elected to pave the streets with brick, and the City Engineer, Mr. F. A. Dunham, well known as the engineer of the excellent highways of Union Co., N. J., has been visiting those places in the West most noted for their use of brick for paving, with a view to obtaining the best possible results for Dunkirk. Proposals for this work will be advertised next week, and contractors should be on the lookout, as a large sum of money is to be expended. The work will be done under Mr. Dunham's specifications and superintendence.

New Cumberland, W. Va.—The town has voted $250,000 for brick paving. Surveys are being made, and as soon as they are completed advertisements will be published for proposals and sale of lands. For particulars address the City Clerk.

Sewers. — *Vermont.* — Morrisville. An engineer has been making a survey for sewers for the village.

Massachusetts.—Westboro. The sewers are to cost not more than $30,000.—Marlboro. Work is progressing on the filter beds for the sewage disposal works.—Holyoke. The City Engineer, Mr. Walther, has prepared plans for about 815 ft. of sewer on Canal and Mosher Sts.; it will be of brick, 5 ft. and 3 ft. diameter, and iron pipe.

Rhode Island.—Pawtucket. Plans for sewage disposal are being prepared by A. R. Sweet, Engineer of the Sewer Commissioners. Mr. C. A. Allen, City Engineer of Worcester, Mass., and Mr. S. N. Gray, of Providence, R. I., have made a report on the disposal of the sewage of the Mosshassuck River Valley, recommending intermittent filtration, and are preparing a report on that of the rest of the city.

New York.—Northville. Sewers are to be built this season.—Oneida. Plans for sewers are being prepared by Mr. Randall, the engineer.—Rochester. The trunk sewer ordinance has been passed.—Binghamton. A sewer is to be built from the asylum to Brandywine Creek.

New Jersey.—South Orange. The Village Trustees have been served with a writ preventing them from taking action upon the sewerage question until after the argument before the Supreme Court in November.—Bridgeton. The Sewer Committee has presented its report, describing the investigation it has made, and recommending the adoption of a proposition made by Mr. C. McMillan to prepare plans and estimates for sewerage on the separate system.

Pennsylvania.—Williamsport. A new sewer ordinance has been passed, providing for the payment of the cost of construction.

Ohio.—Findlay. A sewerage system is proposed.

Indiana.—Anderson. A new and complete system of sewerage is to be built.

Michigan.—Ann Arbor. The Sewerage Committee has recommended that some system of sewerage should be adopted without delay, and has approved the plan of Professor Greene. The Mayor recently vetoed a resolution to raise $20,000 in 2 years for this purpose.

Illinois.—Winnetka. District No. 2 of the sewerage system is to be built. The sewer will be 12 ins. diameter.

Wisconsin.—Sheboygan. The K St sewer being built by S. J. Anderson is of brick, 10 ft. 4 ins. diameter.

Iowa.—Des Moines. The Sewerage Committee of North Des Moines has called attention to the urgent need of sewers, and requested the Council to take action.

North Dakota.—Grand Forks. The sewerage question is under consideration.

Kansas.—Abilene. The Sewer Committee has reported that the cost of sewers would be about $25,000, which the city could not afford as yet.

Washington.—Seattle. The Lake Union sewer tunnel is progressing rapidly. It will be 5,800 ft. long., 6 ft. diameter, with a grade of about 1 in 1,200. Mr. A. Gardner is City Engineer.

California.—Santa Barbara. A plan for sewerage has been prepared by Dr. Winchester.—Oakland. Work will be commenced soon on the South Side intercepting sewer recommended by Mr. Rudolph Henry.

Streets—*Connecticut.*—Birmingham. Elizabeth St. is to be paved at a cost of $10,000.

New York.—Binghamton. Henry St. is to be opened, at a cost of $21,000.

Pennsylvania.—Norristown. The public square is to be paved, the city paying half the cost

Ohio.—Sharpsville. It has been decided to lay cobble stone paving.

Indiana.—Indianapolis. The Board of Public Works proposes to try burnt clay ballast for street paving.

Illinois.—Peoria. Adams street is to be paved with brick instead of asphalt.

Iowa.—Clinton. About $165,000 will be spent on brick paving.

Tennessee.—Memphis. Brick paving is to be laid on Second St. at a cost of $36,000.

Georgia. Savannah. Shell paving is being laid, and costs property owners 80 cts. to $1 per running foot. The street is rolled, the shells put on and rolled and a layer of cinders then put on, watered and rolled.

Alabama.—Alexander City. The streets are to be mac adamized and work will soon be commenced.

California.—Oakland. The engineer's estimate of the Lake Merritt boulevard is as follows:

160,000 cu. yds. stone embankment, 60 cts.	$96,000
300,000 cu. yds. dredging in Lake Merritt, 18 cts	54,000
16,200 lin. ft. parapet wall, $1	16,200
34,400 lin. ft. curbing, 12 cts.	3,888
40,000 cu. yds. earth dressing, 25 cts.	10,000
10,000 cu. yds. fertile earth on sidewalks, 50 cts.	5,000
372,000 sq. ft. cement sidewalks, 12½ cts.	46,500
1,760,000 sq. ft. macadamizing, 7 cts.	123,000
Drains, catch basins, etc.	2,500
	357,288
Contingencies, 10%	35,729
Total	393,017

Bonds.—Highlands, Col.; $40,000 for sewers. Buena Vista, Va.; $40,000 for water-works, sewerage, etc. Muskegon, Mich.; $75,000 for Muskegon Co. courthouse. West Bay City, Mich.; $100,000 for improvements. Brockton, Mass.; $50,000 paving bonds sold to Brockton Savings Bank at 4%. Cleveland, O.; $127,000 funded debt and sewer district 5%; bids received by City Auditor, July 14. Palouse, Wash.; $25,000 for sewers and streets. Great Falls, Mont.; $10,000 for sewers.

ELECTRICAL.

Electric Light.—New plants or improvements are reported as possible at Cedartown, Ga.; Flemingsburg, Ky., address D. J. Hauss; Hot Springs, S. D.; Mariette, Mich.; Wilmington, O.; Seymour, Conn.; Oakville, Ont.; Cuyahoga Falls, O.; Audubon, Ia.; Ozark, Ala.; Newton, N. C.; Greenville, Ala.; Rosedale, Miss.; Edinburg, Ind.; Hamilton, O.; Cambria, Wis.; Joilet, Ill.

Melrose, Mass.—The town has instructed its committee on lighting to prepare an estimate for a township station in accordance with the recent act of the legislature authorizing muncipal plants. Marblehead has also taken steps in the same direction.

Fairmont, S. C.—S. T. McCrary, Secretary of the Fairmount Yarn Mills, wants bids for supplying a plant.

Knightstown, Ind.—J. W. Locke, A. E. Carroll and J. D. Maple have been appointed a committee to select a lighting system.

Butler, Ind.—Bids will be received until July 2 for supplying a plant for 20 lights of 2,000 c. p. with the privilege of more at the same rate.

Rogers Park, Ill.—H. E. Keeler has applied to the Village Board for permission to build a lighting plant.

Pontiac, Mich.—Sealed bids for lighting the city with electric light will be received until July 13 by W. H. Brammitt.

Kansas City, Mo.—The Council Committee on Water and Lights has filed a unanimous report in favor of the municipal control of its electric lighting plant.

Anaheim, Cal.—The city will issue $150,000 of improvement bonds, partly for electric lights.

Portland, Ore.—It is reported that a plant costing $23,000 will be erected in East Portland.

New Companies.—Pana (Ill.) Modern Electric Light, Power and Street Ry. Co.; capital stock, $50,000; incorporators, J. W. Stokes, A. B Corneau, J. Hirbin. Universal Electric Railway Construction Co., Camden, N. J.; capital stock, $500,000; incorporators, J. W. Odenheimer, F. C. Muteer, G. W. Algor. Marion (Ill.) Electric Light and Street Ry. Co.; capital stock, $20,000; incorporators, J. C. Mitchell, W. H. Warder, W. H. Bundy. Leesburg (Fla.) Electric Light and Water Power Co.; capital stock, $50,000; Secretary, B. R. Milam. Ries Electric Specialty Co., Baltimore, Md.; capital stock, $25,000; incorporators, E. E. and L. Ries, L. S. Greenfelder, D. Myers and others. Parlor Electric Co., Paxton, Ill.; capital stock, $2,400; incorporators, C. H. Langford, J. L. Larkin, H. B. Henderson. Salina Light, Heat & Power Co., Salina, Kan.; capital stock, $100,000; directors, R. R. Price, J. M. Mulky, C. S. Cross and others. Peninsular Electric Light Co., Detroit, Mich.; capital stock, $600,000. Rocky Mountain Electric Light & Supply Co., Butte City, Mont.; capital stock, $50,000; incorporators, H. C. Kessler, J. O'Rourke, W. Owsley. Minneapolis (Minn.) Electric Light & Power Co.; capital stock, $750,000; incorporators, C. H Prior, J. W. Griffin, W. D. Hale and others. Eureka Springs (Ark.) Electric Light & Street Ry. Co.: capital stock, $30,000.

CONTRACTING.

Street Work.—*Huntington, W. Va.*—The contract for brick paving has been awarded to Leonhart & Guest, of Wheeling, W. Va., at $1.40 per sq. yd. for Porter pressed brick on 10 ins. of sand and gravel, and including grading. Mr. J. L. Thornburg is the engineer.

Boston, Mass.—Proposals recently received for paving ranged as follows: Block paving, $2.66 to $2.96 per sq. yd.; asphalt paving, $3.50 to $3.75; brick sidewalk, 79 cts. to $1.28 per sq. yd.; edgestone, 28 to 45 cts. per lin. ft.; flagging crosswalk, $1.05 to $2 34 per lin. ft.

Louisville, Ky.—The contract for brick paving has been awarded to C. Selvage, at $10.50 per sq. yd.

Paving Brick.—*Boston, Mass.*—The Street Department has awarded the contract for 200,000 paving bricks for sidewalks to O. S. Foster, of Revere, Mass., at $11.50 per 1 000, delivered.

Louisville, Ky.—The following proposals have been received for vitrified paving brick or blocks: Cloverport Paving & Mfg. Co., Cloverport, Ky., $16.33 per 1,000 for brick, with 33% discount, or $10.12 per 1,000 net. C. L. Cornwell, Louisville, Ky., $15.50 for brick. P. Bannon Louisville, Ky., $16 for blocks. John Porter Co., New Cumberland, W. Va., $19, 60 blocks to the sq. yd. James Drake, Louisville, $21.50, 58 blocks to the sq. yd.

Sewers.—*Manitowoc, Wis.*—The contract has been awarded to J. B. Fox, of Eau Claire, Wis., as follows: 8-in. pipe, 55 cts. per lin. ft.; 10-in., 60 cts.; 12-in., 70 cts.; 15-in., 83 cts.; 20-in., $1.18; 24-in., $1.55; manholes, $30.50; flush tanks, $39 50; timber outfalls, $37.50. There are about 21,000 ft. of sewers, to cost about $17,000. Work is to be completed by November. Mr. W. F. Goodhue, Milwaukee, Wis., is the engineer.

Winona, Minn.—Contracts have been awarded for material and work on Sewer District No. 1, which will be on the Shone system, according to the plans and specifications prepared by the engineer, Mr. U. H. Broughton. Cast-iron pipe, Lake Shore Foundry, Cleveland, O., $27 per ton for pipe and 2½ cts. per lb. for casting; vitrified pipe, Blackmer & Post, of St. Louis, Mo., 13½ cts. per ft. for straight pipe, 47½ cts. for Y branches; ejectors, air pipe, etc., Shone Hydro-Pneumatic Sewerage & Supply Co., $12,750; excavation and pipelaying, T. J. Green, $15.766.

Orange, N. J.—The sewer contract has been awarded to the Empire Construction Co., 50 Broadway, New York, N. Y, which will do the work. The list of bids was given last week.

Wells, Piles, etc.—*Pittsburg, Pa.*—Contracts have been awarded as follows; Drilling 5 water wells, $1.35 per ft.; driving piles, $6 and $9.56 each; iron fence, 92 cts. to $1.10 per ft.

Masonry.—*Willimansett, Mass.*—The contract for bridge masonry and foundations has been awarded by the County Commissioners to Wright, Lyons & Co. Pier masonry, $15 per cu. yd.; abutment masonry, $11; wing wall and retaining masonry, $8; pier foundations within cofferdams, $27; excavation, 30 cts.; riprap deposited and dressed to surface, $1.50.

Fire Hose.—*Baltimore, Md.*—The Fire Department has awarded contracts for fabric hose at 70, 80 and 90 cts. per ft., and for gum hose at $1 per ft.

PROPOSALS OPEN.

Brick Pavements.—*Dunkirk, N. Y.*—F. A. Dunham, City Engineer.

New Cumberland, W. Va.—The City Clerk.

Staunton, Va.—About 1½ miles, on brick or plank foundation, the latter being the Hale patent. Bids for brick and paving, or for paving only. C. H. Harrison, City Engineer.

Washington, D. C.—About 1,200,000 vitrified paving brick. The District Commissioners. July 6.

Sewers.—*Springfield, Mass.*—About 7,000 ft. of 18 × 27 in. to 46 × 69 in. brick. W. L. Dickinson, Superintendent of Sewers. July 3.

Kansas City, Mo.—Section No. 3 of O. K. Creek sewer. E. Butts, City Engineer. June 30.

Street Work.—*Terre Haute, Ind.*—Gutter stone, curbing, crossings and 25,000 to 50,000 cu. yds. of 1 to 2½ ins. broken stone. A. C. Duddleston, City Clerk. July 7.

Pipe Laying.—*Braintree, Mass.*—About 3 miles of 4 and 6-in. water mains. The Water Commissioners. July 9.

Chicago, Ill.—Furnishing and laying 6-in. to 36-in. cast-iron pipe, hydrants and gates. D. H. Burnham, Chief of Construction, World's Columbian Exposition, Rookery Building. June 30.

Brick. *Camden, S. C.*—About 1,000,000 brick for factory. Kershaw County Mfg. Co. July 1.

Clearing and Grading.—About 1,000 acres in Lake County, Ind. Veeder & Martyn, 240 La Salle St, Chicago, Ill. July 1.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have delivered 2 freight engines with cylinders 18 × 24 ins. and driving wheels 54 ins. diameter to the Savannah, Americus & Montgomery. The Richmond Locomotive Works, of Richmond, Va., are building 17 ten-wheel engines, 6 eight-wheel engines and 2 switch engines. The Brooks Locomotive Works, of Dunkirk, N. Y., are building engines for the Wisconsin Central. The Schenectady Locomotive Works, Schenectady. N. Y., have delivered 2 switch engines to the Chicago & Eastern Illinois.

Cars.—Billmeyer & Small, of York, Pa., are building 14 cars for Brazil. The Peninsular Car Co., of Detroit, Mich., has an order for 500 freight cars for the Burlington, Cedar Rapids & Northern. The Kalamazoo Railway Velocipede & Car Co., of Kalamazoo, Mich., is building 100 four-wheel hand cars for a Swiss railway. The Roanoke Machine Works, of Roanoke, Va., are building 25 box cars and 25 flat cars.

Viaduct.—Keepers & Wynkoop, of Milwaukee, Wis., have a contract for a viaduct 2,300 ft. long for the Milwaukee & Wauwatosa Motor Line, across the Menomonee Valley, for $76,666.

Belt Dressing.—The Joseph Dixon Crucible Co., of Jersey City, N. J., recommends the use of its dressing in preference to castor-oil, soap, rosin, etc.

The Universal Brakebeam Co. has opened offices in the Phenix Building, Chicago; the works are at St. Louis. Mr. J. J. Henry is General Manager.

Shailer & Schniglau, of Chicago, have the contract for the pier and breakwater around the Navy Department exhibit, also for the pile approaches and lift bridges over the north and south canals. They will construct and erect 3 roofs, 80 × 140 ft., for the Buffalo Smelting Works.

Sewer Pipe.—The Middlesborough Sewer Pipe & Artificial Stone Co., of Middlesborough, Ky., has enlarged its plant.

The Cleveland (O.) Wheelbarrow & Mfg. Co. has purchased the business of the Cleveland Wheelbarrow & Truck Co.

Companies.—New Birmingham Pipe Works, of New Birmingham, Tex.; Geo. F. Dalton, of New York; Alan Arthur, of New Birmingham; $150,000. Lake Superior Engineering & Construction Co., of Marquette, Mich., $200,600. Illinois Bolt & Nut Co., of Peoria, Ill.; Geo. J. Gibson and J. B. Greenhut; $100 000. The Mineral Mutual Smelting Co., of Mineral, Idaho; C. C. Wing and Michael Duffy; $15,000.

Metal Market Prices.—*Rails.*—New York; $30.75 to $31; old rails, $20 50 for iron and $17 for steel. Pittsburg: $30; old rails, $22.50 to $23 for iron and $17.50 to $18.50 for steel. Chicago: $31.50 to $32; old rails, $23 for iron and $14.50 to $16.50 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1 75 cts.; spikes, 1.9 to 1.95 cts.; track bolts, 2.60 to 2.65 cts. with square, and 2.75 cts. with hexagon nuts. Pittsburg; splice bars, 1.8 to 1.9 cts. for iron or steel; iron or steel spikes, 2 to 2.05 cts.; iron track bolts, 2.75 cts. with square and 2.85 cts. with hexagon nuts. Chicago: splice bars, 1.85 to 1.9 cts. for iron, 2 cts. for steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.8 to 2.9 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $18. Pittsburg: $14.50 to $17. Chicago: $14.50 to $18.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 55 and 45 per cent. on black and galvanized butt-welded; 65 and 52½ on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—New York: 4.4 to 4.45 cts. Chicago: 4.25 to 4.35 cts. St. Louis: 4.25 to 4.3 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1 95 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 2 to 2.15 cts. for tank, 2.3 to 2.6 cts. for shell, 2.5 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2.05 cts.; sheared steel bridge plates, 2.1 to 2.15 cts.; refined bars, 1.8 to 1.9 cts.; steel plates, 2.1 cts. for tank, 2.45 cts. for shell, 2.65 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.3 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2 6 to 2.7 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.

Niles, O., Water-Works.

Notice to Contractors.

SEALED PROPOSALS WILL BE RECEIVED by the Village Council of Niles, Trumbull County, Ohio, UNTIL NOON, JUNE 30TH, 1891, for furnishing material and constructing water-works for said village as follows:

One infiltration or supply basin, one building and one chimney, one storage reservoir, two pumping engines of 1,000,000 gallons each in 24 hours. Bids will be received for compound condensing and compound non-condensing machinery. Also two boilers for said works, including engine foundations, boiler setting, together with all pipes and fixtures complete.

Also the furnishing of 600 ft. of 14-in., 150 ft. of 12-in., 2 400 ft. of 10-in., 16,500 ft. of 8-in., 14,900 ft. of 6-in. and 12 750 ft. of 4-in. cast-iron coated water pipe, aggregating about 810 tons of 2,000 pounds. Also about 22 tons of special castings; also the laying of pipe and specials. Also the furnishing of 80 fire hydrants, 56 stop valves and 56 valve boxes, and setting same.

Bids will be received for the Water-Works System complete, or for any department of work, or material separately. The Council reserves the right to reject any or all bids. Plans and detailed drawings can be seen at the office of the Village Council on and after June 10. Specifications furnished contractors by the consulting engineer or the village clerk. Proposals must be indorsed "Water-Works Proposal."

J. B. STRAWN, Consulting Engineer,
273 Lincoln Ave., Salem, O.
M. J. FLAHERTY, Village Clerk,
Niles, O

NILES, O., May 26, 1891. 22-5t

Sealed Proposals will be received at this office until July 6th, 1891, at 12 M., for the building of a sewerage system for the city of Vicksburg, Miss., as per plans and specifications now on file in the office of the City Clerk. The Board of Mayor and Aldermen reserve the right to reject any and all bids.

R. V. BOOTH, Mayor.

VICKSBURG, Miss., May 25th, 1891. 22-5t.

New Pumping Engines for Atlanta, Ga.

Sealed proposals will be received at the water-works office in the city of Atlanta, Ga., until 12 o'clock meridian, on the 8th day of July, 1891, for furnishing three horizontal high-duty compound pumping engines. Two of said engines to be located close to the Chattahoochee River, near the mouth of Peachtree Creek, and distant from the center of the city about seven miles. Each of these two engines to have the capacity to deliver 10,000,000 galls. in 24 hours against a pressure of 105 lbs. per sq. in. into a receiving reservoir. The other one engine to be located at a point between the river and city, and between three and four miles distant from the center of the city. This engine will be required to pump directly into the city water mains against a varying pressure of from 105 to 160 lbs. per sq. in., and to be so constructed that the pressure may be increased from the first to the second figure within two minutes from the time of receiving a fire alarm at the station.

Bids should be sealed and addressed to the Hon. Board of Water Commissioners, Atlanta, Ga.

Specifications may be had by addressing R. M. Clayton, City Engineer, or Wm. G. Richards, Superintendent, Atlanta, Ga.

The right is reserved to reject any or all bids.

HOWELL C. ERWIN, President.

ATLANTA, Ga., June 5, 1891. 24-4t

Notice to Bridge Builders.

Sealed proposals, marked "Proposals for St. Martin Bridge," will be received by the County Commissioners of Stearns County, Minnesota, at the Office of the County Auditor, St. Cloud, Minn., up to Monday, July 13, 1891, at 3 o'clock P. M., for building and erecting complete an iron highway bridge of one hundred and sixty (160) feet span, across Sauk River, in the town of St. Martin.

Plans can be seen and specifications obtained from the County Auditor or Engineer. Bids will be received for substruction and superstruction separately or both together. A certified check for two hundred ($200) dollars, payable to the order of the County Treasurer, must accompany each bid as a guarantee that, if awarded the work, a satisfactory bond for one-fifth the amount of the bid will be given and contract entered into within five days from date of award. The right is reserved to accept that bid which is for the best interest of the county whether the lowest or not, and to reject all bids if desired.

PAGE & SMITH,
Engineers, St. Cloud, Minn.

Dated at St. Cloud this 6th day of June, 1891.

BARTH. PIRZ,
EDWARD MILLER,
JOSEPH SCHEELAR,
Committee.

24-3t

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Notice to Sewer Contractors.

CITY OF SPRINGFIELD, June 13, 1891,
WATER COMMISSIONERS' BLOCK,
SPRINGFIELD, Mass.

SEALED PROPOSALS indorsed "Proposal for Sewers" will be received by the undersigned until Tuesday, 12 o'clock M., July 3, 1891, for the construction of brick sewers in the city of Springfield, of the following length and interior dimensions:

Length.	Size.
445 ft.	3 ft. 10 ins. × 5 ft. 9 ins.
1,050 "	3 " 4 " × 5 " 0 "
605 "	3 " 2 " × 4 " 9 "
880 "	2 " 4 " × 3 " 6 "
3,000 "	2 " 0 " × 3 " 0 "
360 "	1 " 10 " × 2 " 9 "
360 "	1 " 8 " × 2 " 6 "
360 "	1 " 6 " × 2 " 3 "

Plans and specifications may be seen, blank forms for bids and other information obtained at the City Engineer's Office in said Springfield All bids must be accompanied by a certified check for $500, and a bond for not less than one-third of the total bid will be required of he successful bidder. Bidders will also be required to furnish satisfactory evidence of their business standing as well as their experience and ability to successfully perform the work under consideration.

The right is reserved to reject any or all bids.

WILLIAM L. DICKINSON, Supt. of Sewers.

Per order of the Committee on Sewers and Drains. 25-2t

Notice to Sewer Contractors.

WILMINGTON, DELAWARE.

SEALED PROPOSALS for the construction of approximately 6,400 feet of stone and brick sewers and 1,800 feet of pipe sewers and appurtenances will be received at the office of "The Board of Directors of the Street and Sewer Department" up to 7:30 o'clock p m, June 30, 1891. Plans can be seen at the office of the engineer in charge of sewers, and forms of proposal, contract and specifications will be sent to those desiring them. All bids must be made upon the blank form furnished by the engineer. A certified check for $500 will be required to accompany each proposal and a bond for not less than one-third of his total bid will be required of the successful bidder. The Board reserves the right to increase or diminish the quantities bid for or to reject any or all bids. The internal diameters of the sewers run from 2 feet 9 inches to 9 feet, and some other particulars are approximately as follows:

Length.	Cu. yds. excavation.	Cu. yds. brick masonry.	Cu. yds. stone masonry.
3,326 feet	4,956	875	
1,335 "	2,960	466	
336 "	266	190	565
196 "	520	85	435
540 "	2,700	200	1,970
1,729 "	1,569	18" to 8" pipe.	

T. CHALKLEY HATTON,
Engineer in Charge of Sewers.

Dated June 10, 1891. 24-3t

Iron Bridge.

Sealed proposals will be received at the Bergen County Court House, on Friday, July 10, 1891, at 2 P. M., for building an iron bridge near Westwood, Bergen County, N. J.

Plans and specifications can be seen at the office of Campbell & De Baun, Hackensack, N. J.

Privilege reserved to reject any or all bids.

I. D. BOGERT,
26-2t Westwood, N. J., Chair. Com.

Noblesville Water-Works.

NOTICE TO CONTRACTORS.

SEALED PROPOSALS will be received by the directors of the Noblesville Water & Light Co. at their office, in said city, until 10 o'clock A. M. of Wednesday, July 22, 1891, for furnishing materials and constructing water-works, approximately as follows:

For furnishing—

660 lin. ft. of	12-in. pipe	28	tons
690 " "	10 "	23	"
8 000 " "	8 "	200	"
19,000 " "	6 "	314	"
5,500 " "	4 "	63	"

Also 15 tons of special castings.

Also 1 12-in. valve, 1 10-in., 7 8-in., 21 6-in. and 24 4-in. valves; also 54 valveboxes; also 75 fire hydrants; also pipelaying and setting valves and hydrants.

Also four 6-in. supply wells, approximately 30 ft. deep, and one receiving and pump well 25 ft. diameter and approximately 20 ft. deep.

Bids will also be received for two compound non-condensing pumping engines, each capable of pumping 1,500,000 gallons of water per 24 hours; also for 2 non-compound, non-condensing pumping engines of like pumping capacity as above; the Directors reserving the right to accept either, after receiving bids. Also two return tubular boilers, each 5 ft. diameter and 14 ft. long. Also engine foundations and boiler foundations and settings, complete.

Also one building, to be subdivided into an engine-room and boiler-room.

Bids will be received in the aggregate for any subdivision or the whole of above work, or in detail, at the option of bidders; and the right is hereby reserved to reject any or all bids, or to make any desired modifications or negotiations, after receiving bids, as the Directors may elect.

The necessary drawings, general and detail, will be on file in the company's office for the examination of bidders from and after July 15, and specifications, forms of proposal and forms of contract will be furnished from and after July 10.

JAMES R. CHRISTIAN, President.
J. D. COOK, Toledo, O., Consulting Engineer.
NOBLESVILLE, Ind., June 23, 1891. 26-3t

Rutland, Vt., Water-Works.

Sealed proposals for furnishing labor and materials in excavating and backfilling for a 16-in. cast-iron pipe, furnishing the pipe and laying it, for a pipe line about 3¼ miles in length, will be received by the Water Committee of Rutland, Vt., until noon of Monday, July 13, 1891. Proposal envelopes must be marked "Proposal for Pipe Line," and addressed to the undersigned. The work is to be completed before October 1, 1891. Plans and specifications may be seen at the office of Chappell & Burke, Civil Engineers, Rutland. The right to reject any or all bids is hereby reserved.

GEO. E. ROYCE,
Chairman Water Committee.

RUTLAND, Vt., June 24, 1891. 26-1t

To Water-Works Contractors.

The Village of Madelia, Watonwan County, Minn., will let contract to the lowest responsible bidder July 29, 1891, at one o'clock P. M., high tank and water mains. Right reserved to reject any and all bids. $9,000 to be expended according to plans and specifications on file in Recorder's Office. C. COOLEY, Recorder, Madelia, Minn.

Dated June 17, 1891. 25-4t

Notice to Highway Contractors.

Sealed estimates for regulating, grading and paving with macadam pavement the Jericho road from the Hempstead and Jamaica Plank Road to the Locust Valley branch of the Long Island Railroad, a distance of six miles; and also for regulating, grading and paving with macadam pavement the Jericho road from the Locust Valley branch of the Long Island Railroad to the village of Jericho, at the Jericho Hotel, a distance of six miles, will be received by the Board of Supervisors of Queens Co., on Friday, the 10th day of July, 1891, at the Queens County Court House, at 11 o'clock A. M.

All estimates for either of the above pieces of work shall be accompanied by the written consent of two or more parties to the effect that should the contract be awarded to the party making the estimate they will become sureties in the amount of $25,000.

All estimates for either section shall be accompanied by a certified check in the amount of $5,000, drawn to the order of Robert Seabury, Clerk of the Boad of Supervisors of Queens County.

Plans and profiles, contracts and specifications may be obtained from the Clerk of the Board of Supervisors, at the office of the Engineer, John J. McLaughlin, Clark Building, Jamaica, L. I.

All bids must be made upon blank forms of proposals, which will be furnished by the Clerk at the office of the Engineer aforesaid.

ROBERT SEABURY,
Clerk Board of Supervisors,
26-2t Queens County.

U. S. ENGINEER OFFICE, Savannah, Ga., June 12, 1891. Sealed proposals, in triplicate, will be received at this office until 12 M., city time, on the 10th day of July, 1891, for constructing spur jetties near Fort Clinch, Fla. Attention is invited to acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, vol. 23, page 332, and vol. 24, page 414, Statutes at Large. For all necessary information apply to O. M. CARTER, Capt. Corps of Engineers, U. S. A. 26-2t

PROPOSALS FOR CONSTRUCTING A Viaduct.—Rock Island Arsenal, Rock Island, Ill., June 23, 1891.—Sealed proposals, in triplicate, will be received until 2 o'clock P. M. on Saturday, July 25, 1891, for furnishing, constructing and erecting the iron and all other work complete, except masonry, excavations and fill, for a viaduct from south end of the Rock Island Wagon Bridge, between Rock Island and the city of Rock Island, over the railroad tracks which adjoin the approach to the said bridge, including the raising the said bridge to an inclination required to form a continuous roadway with the viaduct. Plans and specifications, with full instructions, stipulations, etc., and the blank forms on which proposals must be made, can be had on application to Captain M. W. LYON, Ord. Dept. U. S. Army, Commanding. 26-4t

PROPOSALS FOR DREDGING.—U. S. Engineer Office, Montgomery, Ala., June 10, 1891. Sealed proposals in triplicate, for dredging in Apalachicola Bay, Florida, will be received at this office until 12 o'clock noon, standard time, on July 15, 1891, and will be then opened. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. Specifications, instructions for bidders and blank forms for Proposals may be obtained at this office. PHILIP M. PRICE, Captain Corps of Engineers. 25-4t

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WANTED.—Civil Engineer, having an extended experience in difficult mountain location and construction, desires an engagement. Will be at liberty about July 1. Reference, the company now employing him. Address "MANCHESTER," care of Engineering News. 24-3t

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WANTED.—An experienced bridge engineer desires an engagement with some bridge company or on maintenance of way with a railroad company. Address R. G., care Engineering News 24-3t

WANTED.—Engineer at present engaged as locating and constructing engineer desires position on municipal or hydraulic work or on R. R. construction or maintenance of way. Satisfactory references can be furnished. Own good transit and drafting instruments. Position of some permanency desired. Address Box 69, Readsboro, Vt. 25-2t

WANTED.—Position as assistant on waterworks system. Will make surveys, plans, superintend pipe laying, etc. Several years' practical experience. First-class reference from present employer. Address H. F. L., 213 Elm Street, Kalamazoo, Mich. 25-2t

WANTED.—An engineer, experienced principally on city work, wants an engagement. Would like to take charge of a sewer system. First-class draftsman. Write for particulars. Address CITY WORK, care of Engineering News. 25-3t

WANTED—A draftsman who is able to make drawings of structural work, mostly for buildings. Must be able to figure quantities from architects' plans, but it is not required that he should be able to figure strains. Address, with references, CARL MAYER, 5 Brown's Building, Buffalo, N. Y. 2o-1t

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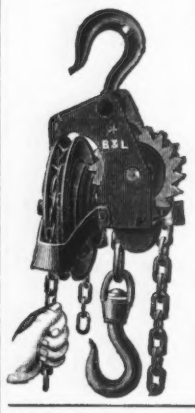

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Dated June 17, 1891. 25-4t

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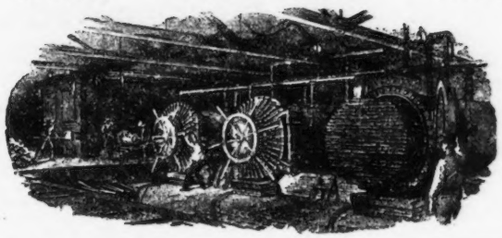

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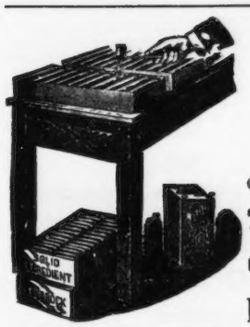

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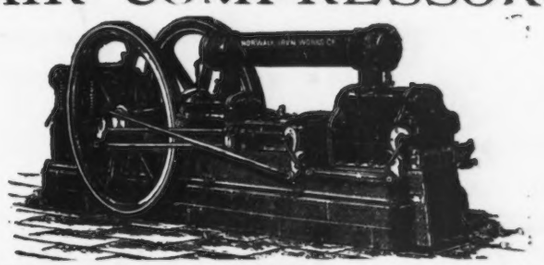

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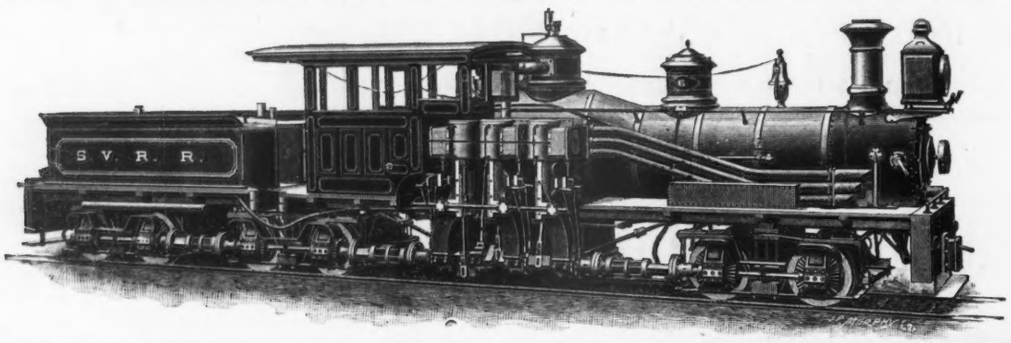

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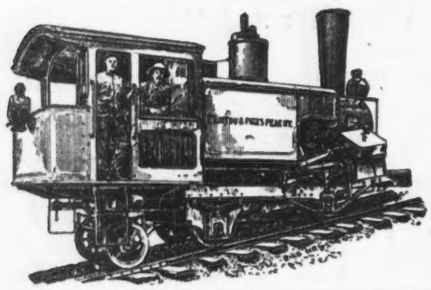

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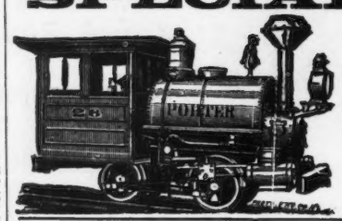

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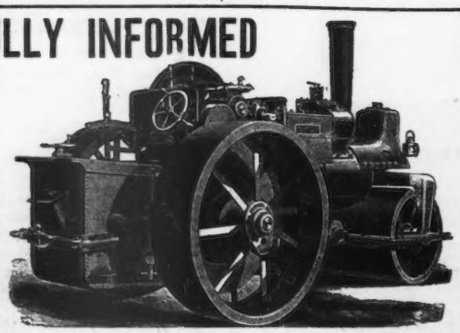
that a pamphlet issued by the Harrisburg Car Co. relating to a trial between the Aveling & Porter and Harrisburg machines at Cambridge, Mass., on Aug. 5, 1890, is a tissue of misrepresentations.

During a week's work of the Harrisburg Roller at Cambridge several of the spokes of the rolling wheels were or became loose, the grate bars were twisted from the excessive blast of the double cylinders and the imitation double speed gear became loose and out of order. The engine was complicated and noisy and incomparably inferior to the Aveling & Porter simple single-cylinder ngine.

Despite these breakdowns and faults, the Streets Committee voted (3 to 2) to buy the Harrisburg Roller, and the animus against "The English Roller" was so great with certain members of the committee that *two of them actually voted not to hear the representative of the Aveling & Porter machine in support of his own roller.* The two Aldermen of the committee (including the chairman) voted for the A. & P. Roller and the three councilmen against it.



A Harrisburg Roller at Indianapolis, Ind., *after about six weeks' use,* has twisted its grate bars, burned its baffle-plates broken the large casting and pin which support the forward wheels, and otherwise has shown a serious amount of wear and tear ! ! ! See report of the city authorities of Madison, Wis. on the relative merits of the Aveling & Porter and Harrisburg Rollers.

"I cannot understand how any intelligent comparison can allow of anybody choosing the Harrisburg Roller to yours; but I suppose that the intelligent comparison is lacking and that some other influences prevail."—Col. John Y. Culyer, Mem. A. S. C. E., Civil Engineer and Landscape Architect, New York City, and Consulting Engineer Brooklyn Parks Commission, Aug. 8, 1890.

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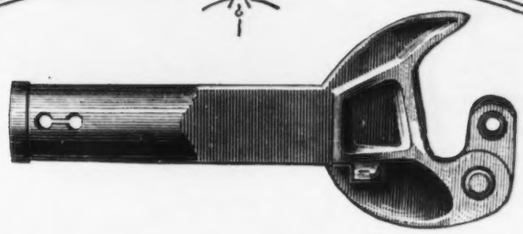

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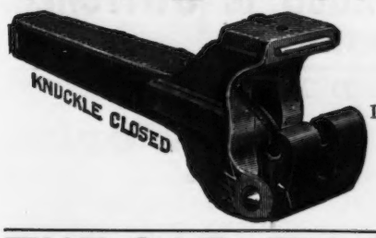

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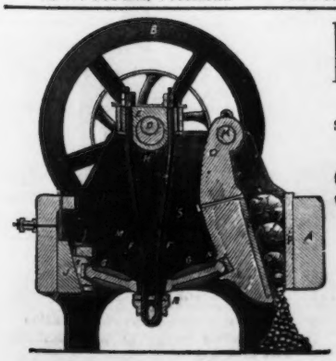

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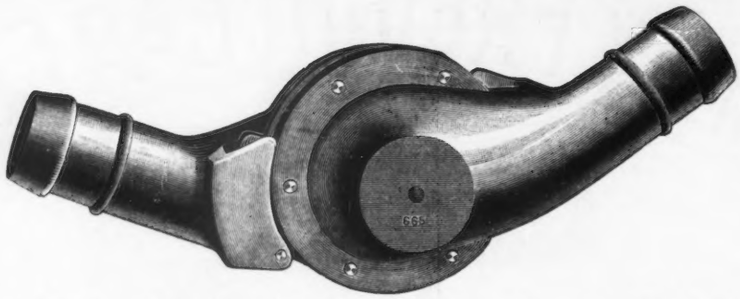

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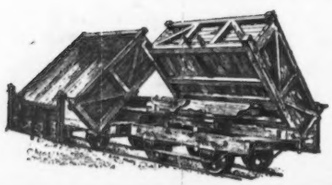

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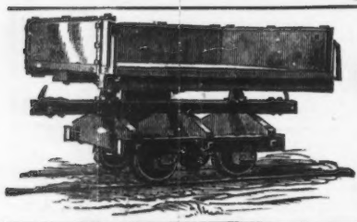

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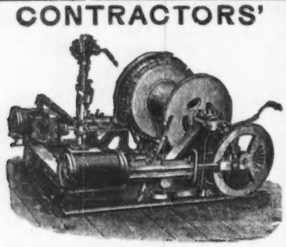

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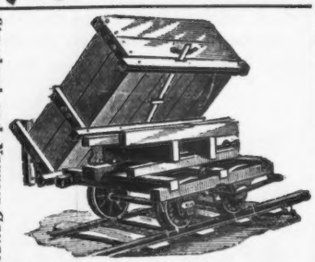

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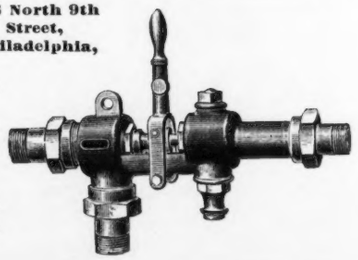

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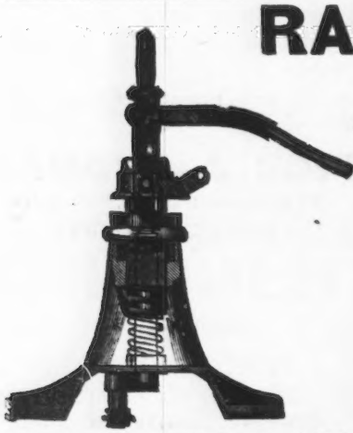

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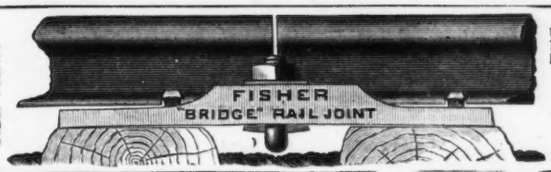

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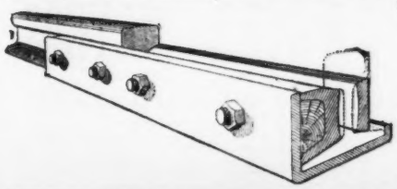

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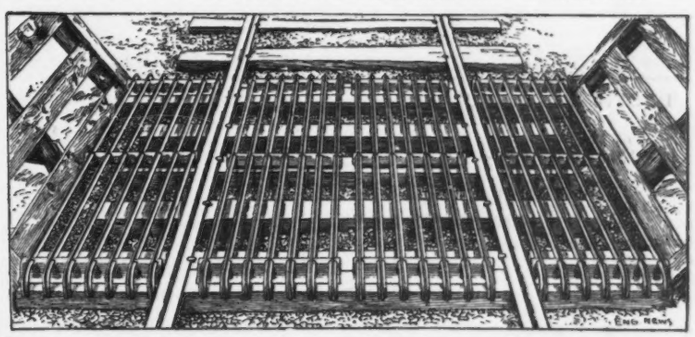

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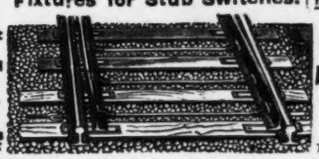

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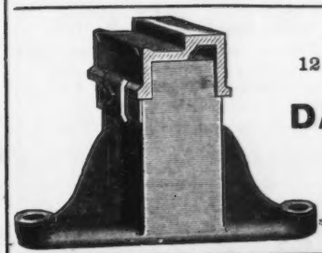

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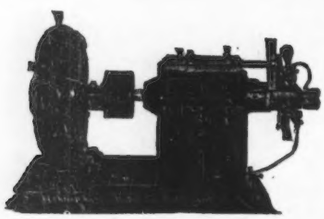

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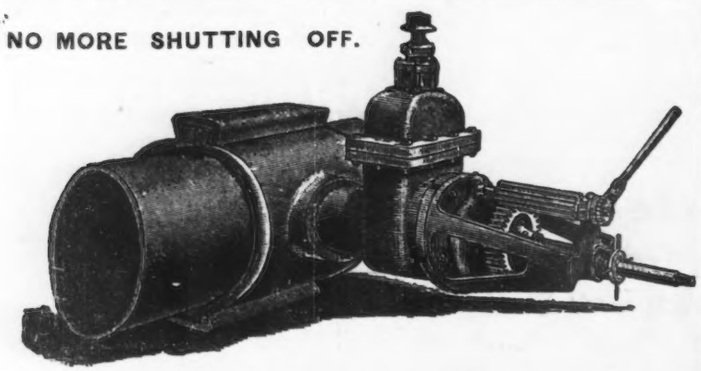

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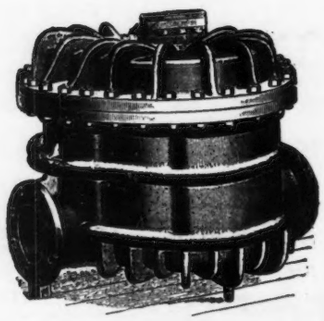

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A MARVELOUS TEST!

HON. ROBERT E. SMITH, Commissioner Public Works, Providence, R. I.: NEW YORK, June 8, 1891.

DEAR SIR :—We have had the pleasure of furnishing your department during the past ten years about 5,500 Crown Meters. In the last shipment of fifty ½ Crown Meters furnished you, we sent five of our "A" style of Crown Meter. We write to ask you if your department has tested any of that lot of meters, and, if so, will you kindly send us a copy of such test ? Yours very truly,

JOHN C. KELLEY, President.

ROBERT E. SMITH, Commissioner. [COPY.] DEPARTMENT OF PUBLIC WORKS, COMMISSIONER'S OFFICE, CITY HALL.

JOHN C. KELLEY, Esq., President National Meter Co., 252 Broadway, New York : PROVIDENCE, R. I., June 11, 1891.

DEAR SIR :—Your request of the 8th inst., for a copy of the test for accuracy of a ⅝ Crown Meter, "A" pattern, is received. Enclosed find copy of the test of meter No. 84,169. Yours respectfully, ROBERT E. SMITH, Commissioner,

by W. F. SLADE, Secretary.

TEST FOR ACCURACY ½-INCH CROWN METER NO. 84,169, "A" PATTERN, MARCH 31 AND APRIL 2 AND 3, 1891.

WATER PRESSURE.	FAHR.	TIME.			METER.	TANK.	OUTLET. Brown & Sharpe Disk.	PER CENT.
		Hours.	Minutes.	Seconds.				
70 lbs.	70 degrees.	...	4	...	10 feet.	623 lbs.	½-in.	0
70 "	70 "	...	7	23	10 "	617 "	¼ "	0.9
70 "	70 "	...	30	5	10 "	618 "	⅛ "	0.8
70 "	70 "	...	22	20	2 "	124 "	1/16 "	0.4
70 "	70 "	1	13	30	2 "	127 "	1/32 "	1.9
70 "	70 "	2	43	...	2 "	126 "	1/50 "	1.2
70 "	70 "	3	23	...	1 "	64 "	1/75 "	2.7
70 "	70 "	5	50	...	1 "	64½ "	1/100 "	3.5

WHAT DOES THIS TEST SIGNIFY ?

One Cubic Foot of Water on 1-2-in. Stream was Registered in 24 Seconds.

" " " 1/100-in. " " 21,000 "

The disks used were made by Brown & Sharpe Manufacturing Company.

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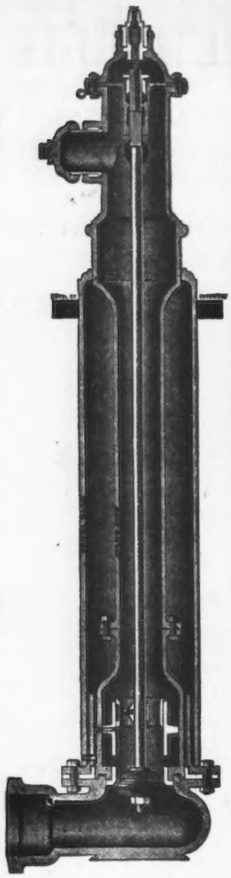

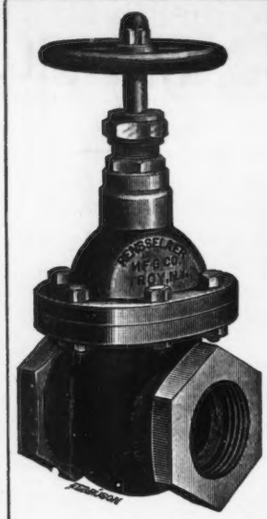

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The fact is, Prof. Baumeister has collected pretty much all the information which various American engineers have been sent to Europe for in recent years, and we advise those municipalities which are not financially able to give their city engineer a year in Europe for the purpose of sewer exploration to buy this book and present it to their engineer if he has not already bought one. But we think nearly every city engineer in the cities of over 8,000 inhabitants has bought one already, as we have sold nearly enough to cover the number of such given by the last census report. You will not make a mistake in buying this book, as no other treatise on the same subject will be published in this country for years to come, if at all, which will cover the same important ground which it does.

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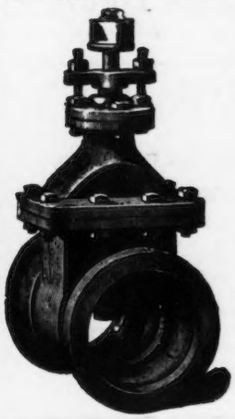

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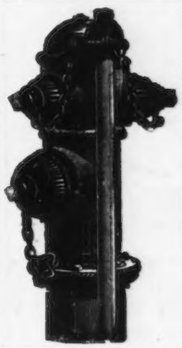

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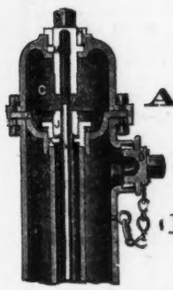

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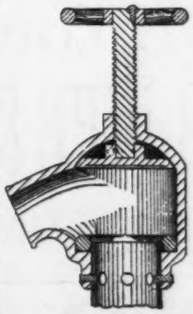

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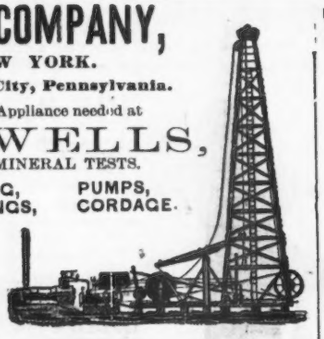

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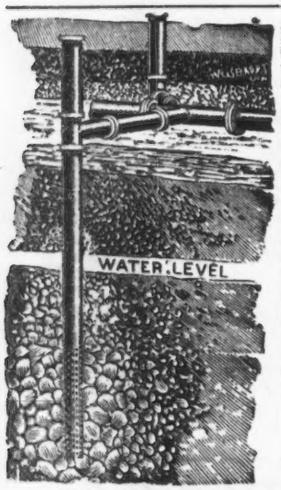

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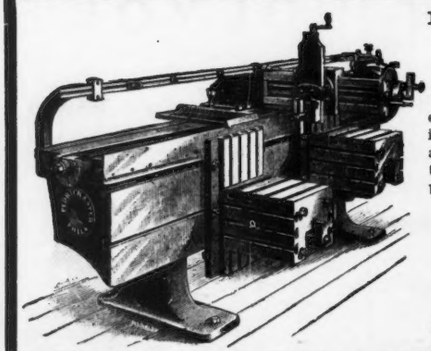

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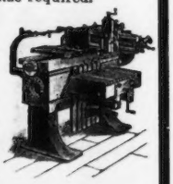

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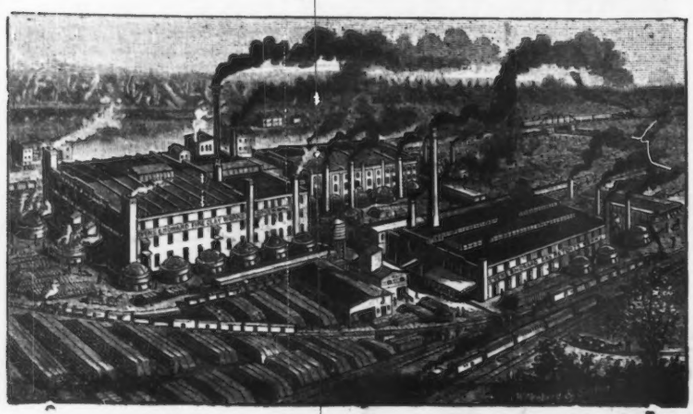

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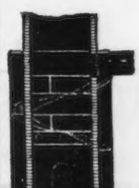

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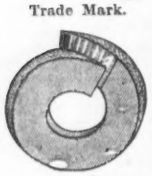

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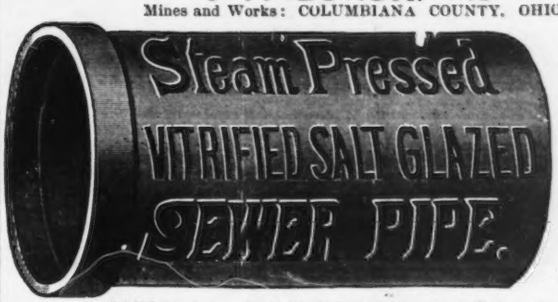

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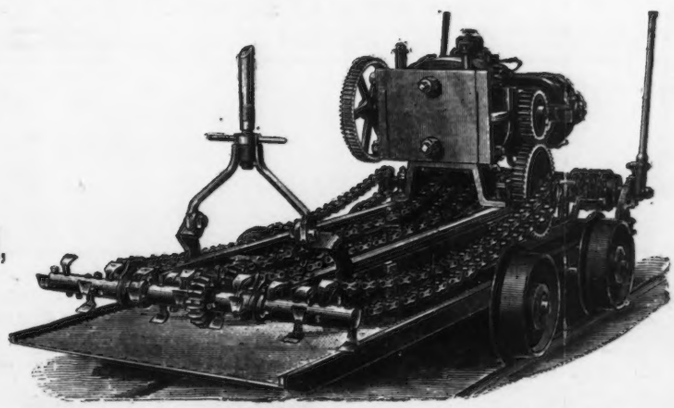

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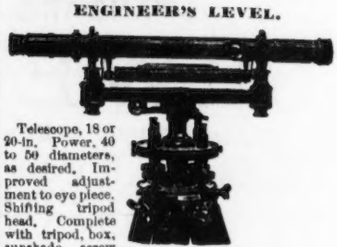

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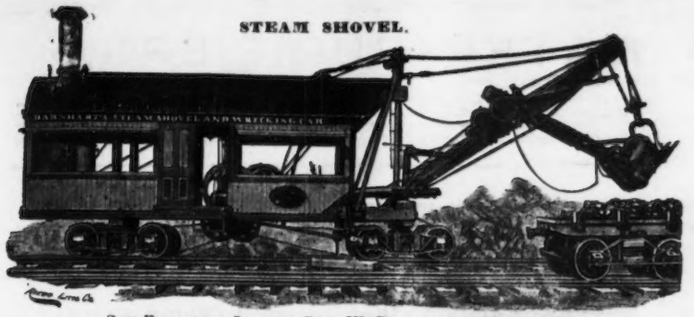

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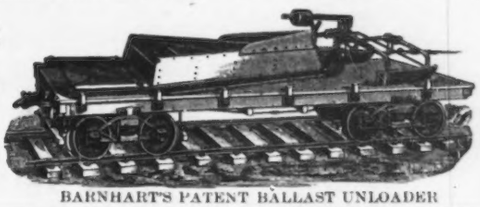

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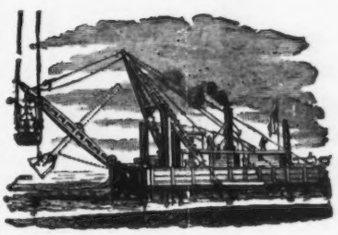

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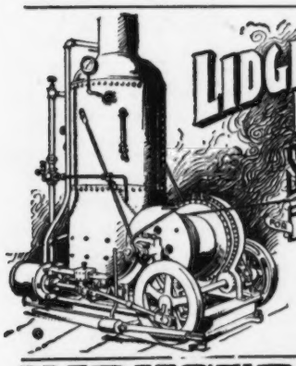

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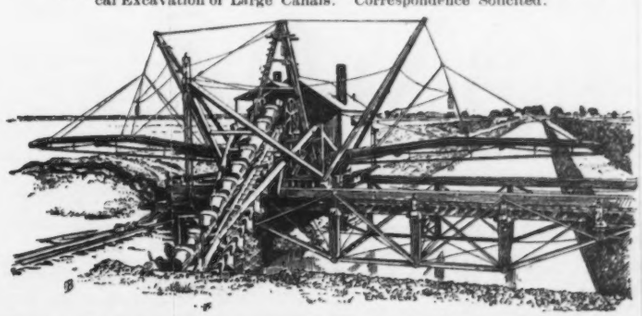

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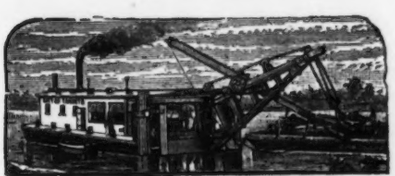

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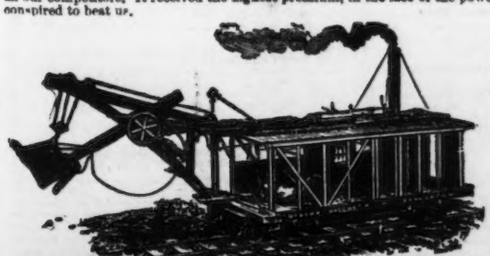

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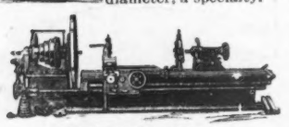

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Edwards & Co., Joseph, 412 Water St., N. Y.	31
Eggleston & Dennis, Richmond, Va.	2
Elmira Bridge Co., Elmira, N. Y.	25
Endicott & Macomber, Boston	1
Engineering Employment Bureau, Syracuse, N. Y.	22
Eppinger & Russell, 160 Water St., N. Y.	27
Estrada, Kenyon & Gray, Pittsburgh, Pa.	2
Evans, Geo. A., 40 Wall St., N. Y.	Front Cover.
Evens & Howard, St. Louis, Mo.	14
Fanning, J. T., St. Paul, Minn.	2
Farrel Foundry & Machine Co., Ansonia, Conn.	15
Fauth & Co., Washington, D. C.	20
Ferris, G. W. G., & Co., Pittsburgh, Pa.	2
Field, Wm. P., Newark, N. J.	2
Filley, H. H., Kansas City, Mo.	2
Fisher Rail Joint Works, Trenton, N. J.	9
Fitzgerald, J. L., Schenectady, N. Y.	2
Fitzgerald, W. T., Washington, D. C.	1
Fleming, Howard, 23 Liberty St., N. Y.	15
Foley, John T., Nashville, Tenn.	3
Ford, J. T., 34 Broad St., N. Y.	2
Forsaith & Co., S. C., Manchester, N. H.	22
Foster, W. C., 52 Broadway, N. Y.	2
French & Co., Samuel H., Philadelphia, Pa.	30
Frost & Adams, Boston, Mass.	20
Fuller, E. F., 11 Wall St., N. Y.	2
Fuller, Frank L., 12 Pearl St. Boston, Mass.	2
Galvin Brass & Iron Works, Detroit, Mich.	13
Gibbon Duplex Ry. Tracks, 1 Broadway	1
Gilbert, B. L., 50 Broadway, N. Y.	1
Glamorgan Co., Lynchburg, Va.	33
Gloucester Iron Works, 401 Chestnut St., Philadelphia, Pa.	32
Gordon Steam Pump Co., Hamilton, O.	30
Gould Coupler Co., 120 Broadway, N. Y.	1
Gould, W. Reid, Potter Building, N. Y.	30
Gould Packing Co., East Cambridge, Mass.	16
Gray, Samuel M., 26 Westminster St., Providence, R. I.	2
Gribble, T. G., 76 Broad St., N. Y.	3
Griffin Machine Works, P. H., Buffalo, N. Y.	36
Griffin Wheel & Foundry Co., Chicago, Ill.	36
Groton Bridge & Mfg. Co., Groton N. Y.	25
Grunow & Wilson, Omaha, Neb.	2
Gurley, W. & L. E., Troy, N. Y.	30
Hall Electric Signal Co., N. Y. City	1
Harlow & Co., Jas. H., Pittsburgh, Pa.	28
Harrington, Edwin Son & Co., Philadelphia, Pa.	23
Haskin Wood Vulcanizing Co., 40 Wall St., N. Y.	5
Hastings Pavement Co., 140 Pearl St., N. Y.	15
Hathaway & Co., I. H., Philadelphia, Pa.	26
Hawks, A. McL., Denver, Colo.	3
Heilstrou, Victor, Chicago, U. S. Exp. B'ld'g.	2
Heer & Selig, 132 Madison St., Chicago, Ill.	20
Heller & Brightly, Philadelphia, Pa.	20
Hersey Mfg. Co., South Boston, Mass.	10
Hercules Power Co., Cleveland, O.	5
Hering, Rudolph, 277 Pearl St., N. Y.	2
Hildebrand, W., New York	6
Hildreth, R. W., & Co., 2 Wall St., N. Y.	2
Hill, John W., Cincinnati, O.	2, 30
Hodge & Co., E., Boston, Mass.	28
Holmes, A. L., Grand Rapids, Mich.	20
Holly Manufacturing Co., Lockport, N. Y.	29
Holyoke Hydrant & Iron Works, Holyoke	13
Hopkins, W. F., Laclede Building, St. Louis, Mo.	26
Howard Hydraulic Cement Co., Chattanooga, Tenn.	15
Howell, D. J., Washington, D. C.	2
Hoyt, A. V., Phillipsburg, Pa.	2
Hughes Steam Pump Co., Cleveland, Ohio.	30
Hunt & Co., Robt. W., Chicago, Ill.	3
Hunt & Clapp, Pittsburgh, Pa.	2
Hutton, Wm. R., 35 Broadway, N. Y. City	3
Hyatt Pure Water Co., Newark, N. J.	14
Illinois Central R. R., Chicago, Ill.	22
Industrial Works, Bay City, Mich.	21
Ingersoll-Sergeant Rock Drill Co., 10 Park Place, N. Y.	5
Iredell, F. W., 10 Park Place, N. Y.	6
Jackson & Woodin Mfg. Co., Berwick, Pa.	32
Janney-Hein Company, Pittsburg, Pa.	7
Jenks, Henry F., Pawtucket, R. I.	1
Johns Mfg. Co., H. W., New York	16
Johnson & Wilson, 45 Broadway, N. Y.	34
Johnson & Flad, St. Louis, Mo.	2
Joseph Dixon Crucible Co., Jersey City, N. J.	29
Ketcham & Co., Chas. F., 27 and 39 Nassau St., N. Y.	30
Keuffel & Esser Co., 127 Fulton St., N. Y.	20
Keystone Bridge Co., Pittsburgh, Pa.	25
Kilbourne & Jacobs Mfg. Co., Columbus O.	29
Kinney, E. C., 1630 Champa St., Denver, Colo.	2
King Iron Bridge & Mfg., Cleveland, O.	35
Lacy Mfg Co., Los Angeles, Cal.	18
Lafayette College, Easton, Pa.	3
Laidlaw & Dunn Co., Cincinnati, O.	31
Lake Shore Foundry, Cleveland, O.	33
Lane Bros., Bridge & Const. Co., Newark, O.	27
Landreth, Olin H., Nashville, Tenn.	2
Lawrence Cement Co 67 William St., N. Y. City.	34
Lehigh Valley Creosoting Works, Perth Amboy, N. J.	27
Lehmann, Karl L., 113 Adams St., Room 17, Chicago, Ill.	2
Lennon, J. M., Minneapolis, Minn.	3
Leslie & Trinkle, Philadelphia, Pa.	15, 34
Levering & Garrigues, 218 S. 4th St., Philadelphia	24
Lewis, Harry J., Sta. B., Pittsburgh, Pa.	3
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.	21
Lima Machine Works, Lima, O.	6
Livengood, W. C., Philadelphia, Pa.	24
Locke, A. W., North Adams, Mass.	2
Long & Co., Dennis, Louisville, Ky.	33
Lookout Sewer Pipe Co., Chattanooga, Tenn.	15
Ludlow Valve Mfg. Co., Troy, N. Y.	13
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Maslin & Son, Jersey City, N. J.	30
McCain, F. J. & Bro., Chicago, Ills.	27
McConway & Torley Co., Pittsburgh, Pa.	7
McEwen, A. C., Jersey City, N. J.	2
McGrew & Niedermeyer, Cincinnati, O.	2
McLeod, John, Louisville, Ky	2
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McMath & Sons, R. E., St. Louis, Mo.	3
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Marion Steam Shovel Co., Marion, O.	2
Mason Regulator Co., Boston	1
Massillon Bridge Co., Massillon, O.	24
Meacham & Wright, 98 Market St., Chicago	15
Meier & Foster, St. Louis, Mo.	3
Mellert F'dy & Machine Co., Reading, Pa.	33
Michigan Pipe Co., Bay City, Mich.	32
Middleton, W. S., 52 John St., N. Y.	22
Middletown Car Works, Middletown, Pa.	8
Millar & Sons, Chas., Utica, N. Y.	17
Minnigerode & Co., 40 Broadway, N. Y.	34
Missouri Pacific R. R., St. Louis, Mo.	8
Missouri Valley Bridge & Iron Works, Leavenworth, Kan.	24
Moffet, Hodgkins & Clarke, 315 Pine St., N. Y.	3
Morse & Son, A. J., Boston, Mass.	22
Morison-Allen Co., N. Y. and Chicago.	22
Mosby, S. B & Co., Bedford City, Va.	2
Montague & Co., Chattanooga, Tenn.	17
Mundy, J. S., Newark, N. J.	27
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National Meter Co., 252 Broadway, N. Y.	11
National Tube Works, Boston	32
National Water Purifying Co., New York	34
National Water Supply Co., Cincinnati	14
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N. Y. Car Wheel Works Co., Buffalo, N. Y.	34
N. Y. Railway Supply Co., 40 Wall St., N. Y.	9
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Norwalk Iron Works Co., So. Norwalk, Conn.	5
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O'Flaherty & Son, Daniel, Kansas City, Mo.	3
Ohio Pipe Co., Columbus, O.	33
Ohio Valley Fire Clay Co., Toronto, O.	19
Oil Well Supply Co., New York	14
Old Dominion Creosoting Works, Norfolk, Va.	27
Osborne & Sons, R. B., Philadelphia, Pa.	3
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Otis & Chapman, Boston, Mass.	21
Otto Gas Engine Works, 151 Monroe St., Chicago.	19
Paine & Sons, Chas., 71 Broadway, N. Y.	3
Pancoast & Rogers, 28 Platt St., N. Y.	33
Parker, M. S., Great Falls, Mont.	3
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Pennsylvania Steel Co., Steelton, Pa.	1, 9, 25, 28
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Phosphor Bronze Smelting Co., Phila., Pa.	9
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Pittsburgh Reduction Co., Pittsburgh, Pa.	16
Pond Engineering Co., St. Louis, Mo.	30
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Porter Boiler Mfg. Co., Chicago, Ill.	23
Porter, H. K. & Co., Pittsburgh, Pa.	6
Porter Mfg. Co., Syracuse, N. Y.	7
Potts Pipe Fittings Co., Columbus, O.	4
Pottsville Iron & Steel Co., Pottsville, Pa.	26
Prosser & Son, Thomas, 15 Gold St., N. Y.	3
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Queen & Co., Phila., Pa.	30
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Rampo Iron Works, Hillburn, N. Y.	3
Rand Drill Co., N. Y. City	7
Randolph, T. F., Cincinnati, O.	20
Raymond & Bay, San Francisco, Cal.	3
Rendrock Powder Co., 23 Park Pl., N. Y.	5
Rensselaer Mfg. Co., Troy, N. Y.	12
Richmond Locomotive & Machine Works, Richmond, Va.	6
Rickter & Wing, 112 White B'ld g, Buffalo, N. Y.	3
Ricketts, Palmer C., Troy, N. Y.	3
Ripley, H. C., Galveston, Tex.	3
Riter & Conley, Pittsburgh, Pa.	28
Rochester Bridge & Iron Wks, Rochester, N. Y.	24
Rosewater, Andrew, Omaha, Neb.	2
Ross & Sanford, Fuller Bldg., Jersey City, N. J.	30
Rue Mfg. Co., Philadelphia, Pa.	8
Ryan-McDonald Mfg. Co., Baltimore, Md.	8
Saabye, Oscar, Roanoke, Va.	2
Safety Car Heating & Lighting Co., 160 B'way, N. Y.	8
Sanne, Oscar, Milwaukee, Wis.	2
San Francisco Bridge Co., San Francisco, Cal.	21, 24
Saxton, E., Washington, D. C.	3
Schrader & Son, A., 32 Rose St., N. Y.	30
Shailer & Schnigian, Chicago, Ill.	26
Sharon Boiler Works, Sharon, Pa.	28
Shaw, Edw. S., 146 Franklin St., Boston, Mass.	3
Shedd Water Meter Co., Providence, R. I.	10
Shiffler Bridge Co. Pittsburgh, Pa.	25
Sicilian Asphalt Paving Co., New York	15
Sikes, F. G. & G. R., Buffalo, N. Y.	3
Smith, A. P., Newark, N. J.	10
Smith Bridge Co., Toledo, O.	26
Smith, Frederick H., Balto., Md.	3
Smith, Jesse M., 36 Moffat Block, Detroit, Mich.	3
Smith & Valle Co., Dayton, O.	31
Snyder, Frank, Columbus, O.	3
Sooysmith & Co., 2 Nassau St., N. Y.	24
Southern Granite Co., Atlanta, Ga.	26
Southwark F'dy & Machine Co., Phila., Pa.	31
Spiral Weld Tube Co., 43 John St., N. Y.	32
Spon, E. & F. N., 12 Cortlandt St., N. Y.	16
Sparks & Evans, Phila., Pa.	27
Staats, R. P. & J. H., 29 Broadway, New York	26
Standard Thermometer Co., Peabody, Mass.	29
Stanwix Engineering Co., Rome, N. Y.	3
Stebbings, W. L., 22 Fifth Ave., Chicago	3
Steubner, G. L. & Co., Long Island City, N. Y.	8
Stow Flexible Shaft Co., Phila., Pa.	5
Stow Mfg. Co., Binghamton, N. Y.	5
Stout, Edmund C., 42 B'way, N. Y.	3
Strupakoff & Naegeley, Pittsburgh	3
Sumner & Goodwin, 15 Oliver St., Boston, Mass.	13
Tamaqua Mfg. Co., Tamaqua, Pa.	13
Temple, J. C., Dayton, O.	2
Thacher & Breymann, Toledo, O.	14
Thiele, E., 78 William St., N. Y.	15
Thomson-Houston Motor Co., Boston, Mass.	23
Thomson Meter Co., Temple Court, N. Y.	10
Tippett & Wood, Phillipsburg, N. J.	28
Toledo F'ry & Machine Co., Toledo, O.	21
Tomkins Co., Calvin, 250 Broadway, N. Y. City	15
Trautwine's Pocket Book	16
Union Akron Cement Co., Buffalo, O.	15
Union Bridge Co., 1 B'way, N. Y.	25
Union Hydraulic Works, Phila., Pa.	32
Union Switch & Signal Co., Swissvale, Pa.	1
Union Water Meter Co., Worcester, Mass.	10
United States Fire Clay Co., Pittsburgh, Pa.	19
Valle & Young, Baltimore, Md.	27
Valley Pump Co., Easthampton, Mass.	30
Vanderbilt & Hopkins, 120 Liberty St., N. Y.	27
Van Dorston Cushioned Car Coupling Equipment Co., 308 Chestnut St., Phila.	7
Van Duzen & Tift, Cincinnati, O.	15
Van Wie, Irwin, 48 to 52 S. West St., Syracuse, N. Y.	
Variety Iron Wks. Co., Cleveland, O.	
Vermeule, C. C., 71 B'way, N. Y.	
Vulcan Iron Works, Chicago, Ill.	
Waddell, J. A. L., Kansas City, Mo.	3
Warder, J. H., Rand-McNally B'ld'g, Chicago	3
Waring, Jr., Geo. E., Newport, R. I.	3
Waring, Chapman & Farquhar, Newport, R. I.	3
Warner, Henry A., New Haven, Conn.	19
Warren Chemical & Mfg. Co., 31-33 Fulton St., N. Y.	16
Warren F'dy & Machine Co., 160 B'way, N. Y.	33
Warren Scharf Asphalt Paving Co., 31 Fulton St. N. Y.	34
Webber Rail Joint Mfg. Co., 74 5th Ave., N. Y.	9
Weir Frog Co., Cincinnati, O.	9
Western Cement Assoc'n, Louisville, Ky.	15
Westinghouse Air Brake Co., Pittsburgh Pa.	4
White, R. T., 12 Pearl St., Boston	9
White, Wm. Henry, 32 Pine St., New York	3
Wilkins & Davidson, Pittsburgh, Pa.	3
Wilson Brothers & Co., Drexel Building, Phila., Pa.	3
Wisconsin Bridge & Iron Co., Milwaukee, Wis.	27
Wolfmann, Keith & Co., 11 Wall St., N. Y.	6
Wood & Co., R. D., Phila., Pa.	16
Woolman, G. S., 116 Fulton St., N. Y.	20
Wootton, E. H., 35 B'way, N. Y.	15
Worthington, Henry R., N. Y. City	31
Wright & Wood, Knoxville, Tenn.	3
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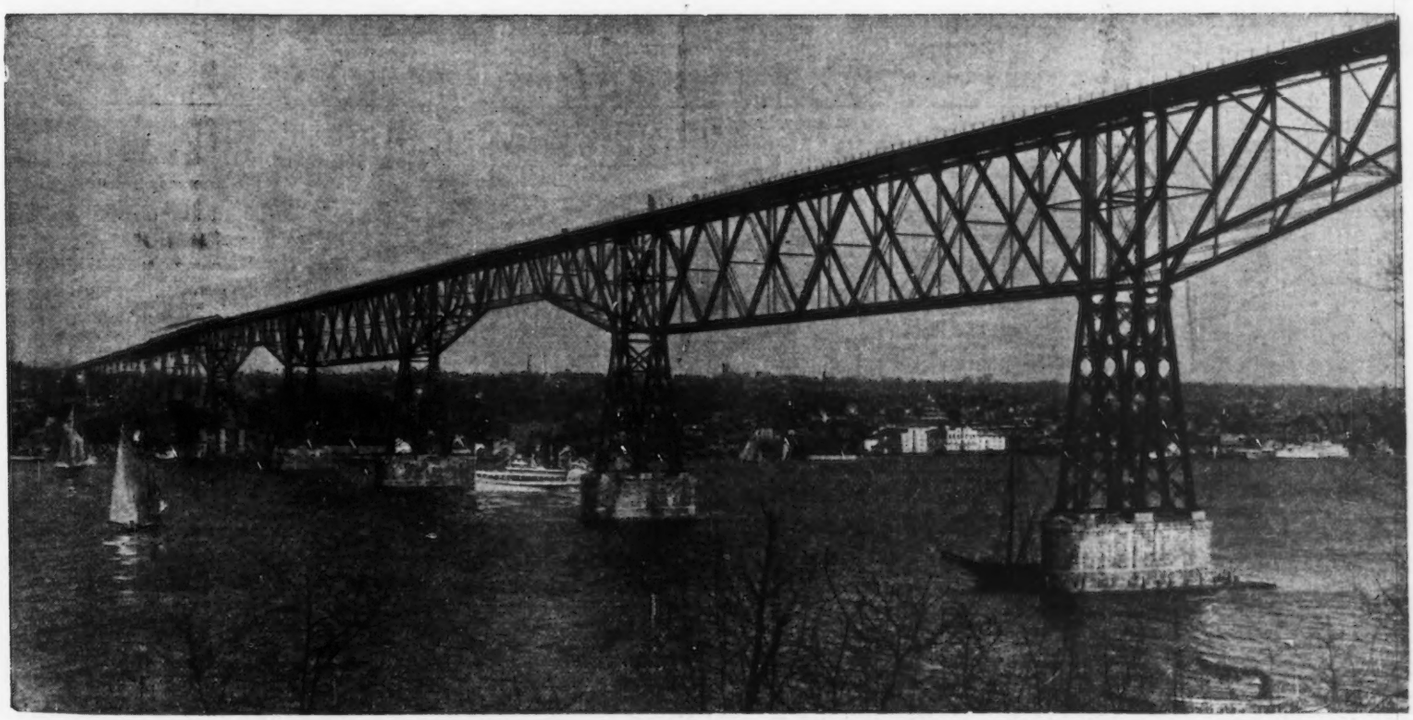

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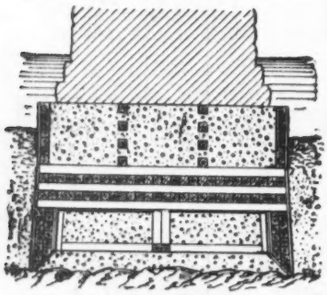

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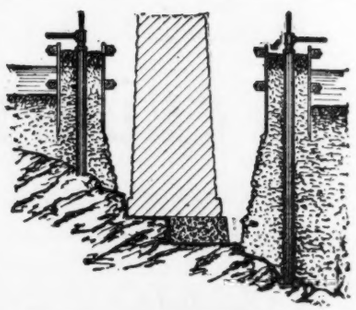

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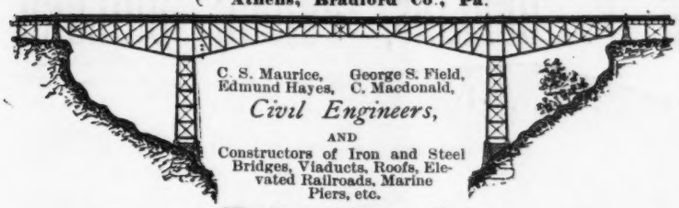
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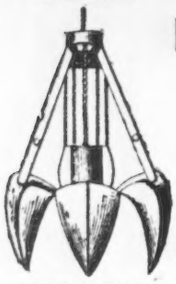

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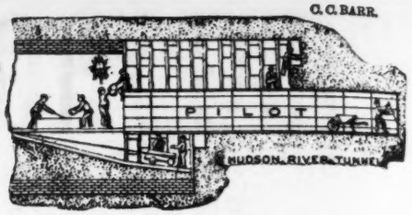

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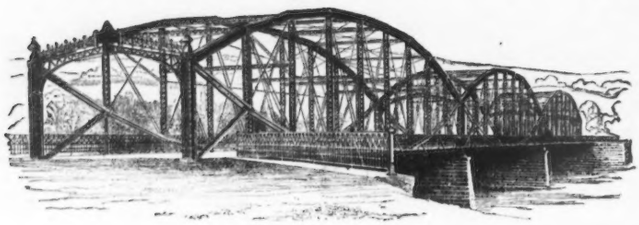

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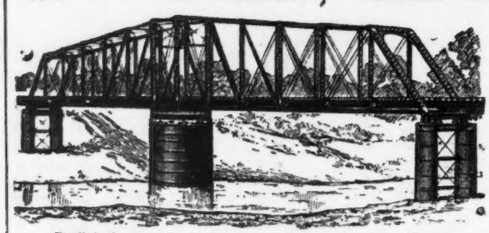

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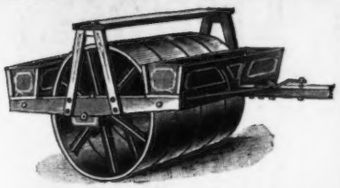

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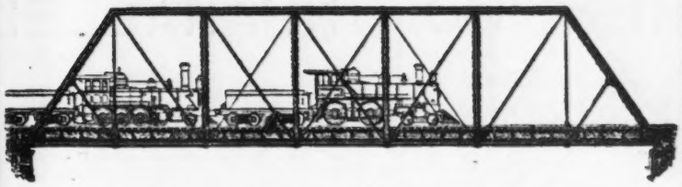

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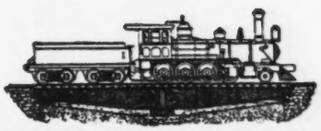

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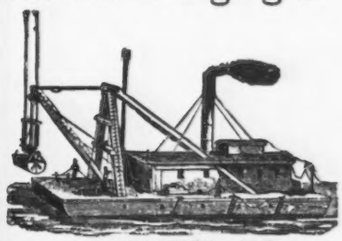

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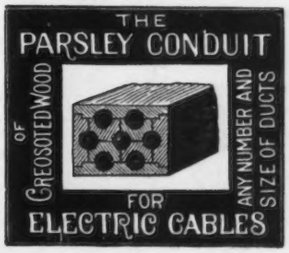

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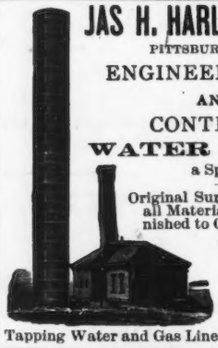

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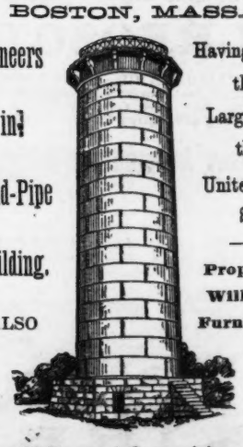

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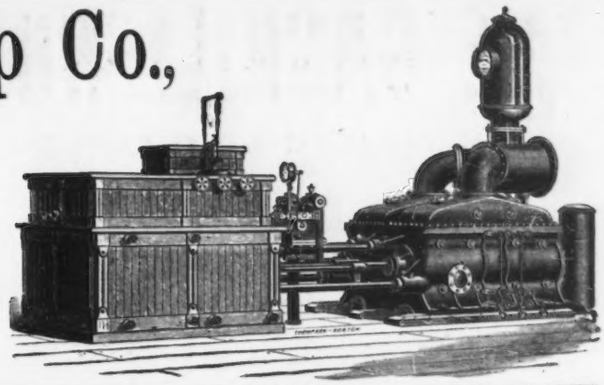

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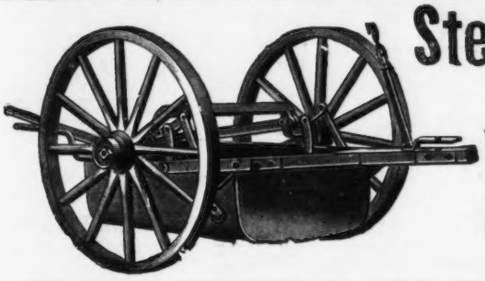

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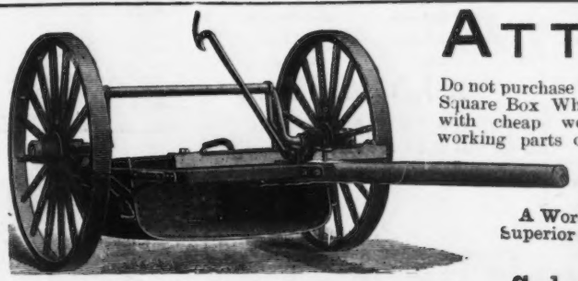

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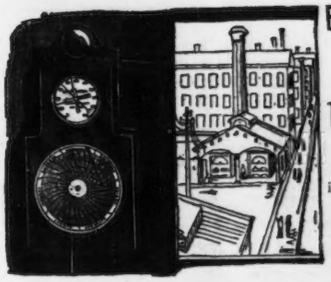

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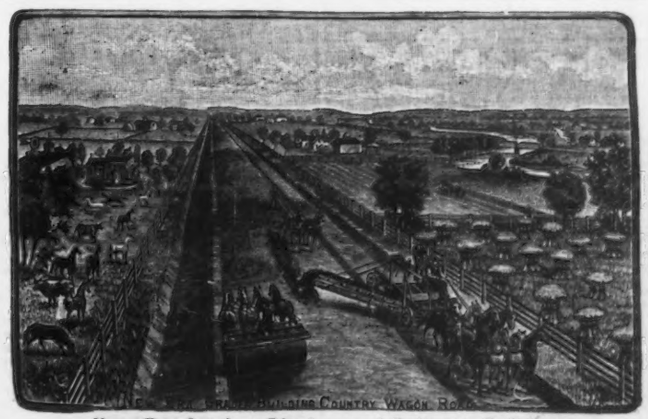

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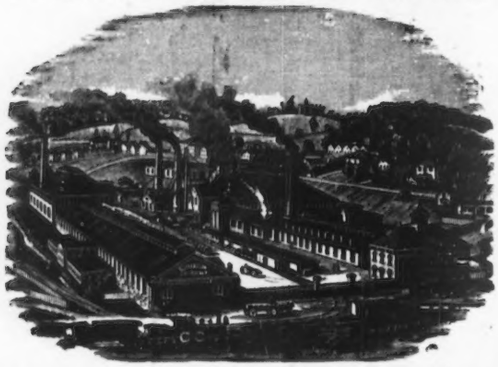

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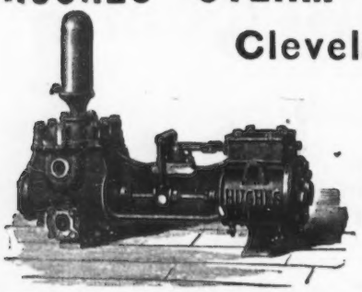

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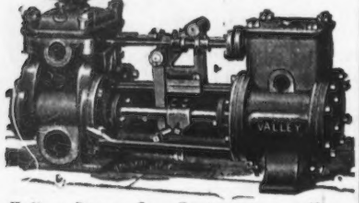

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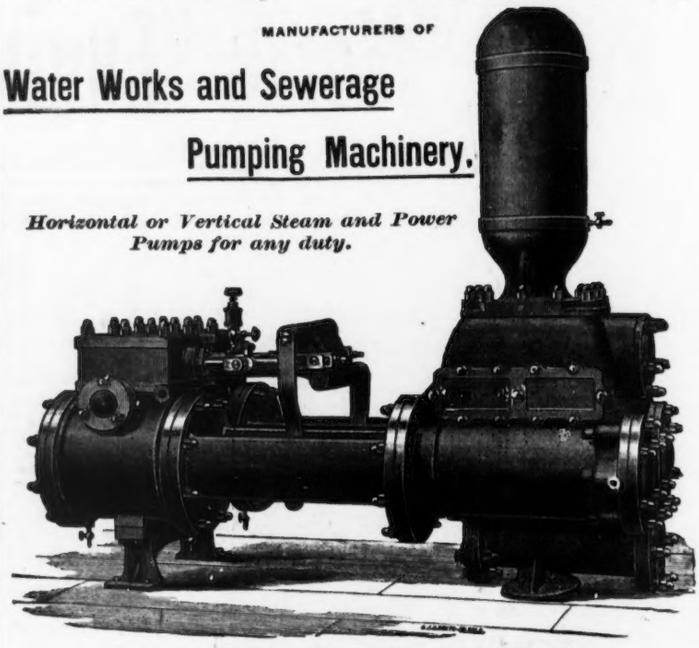

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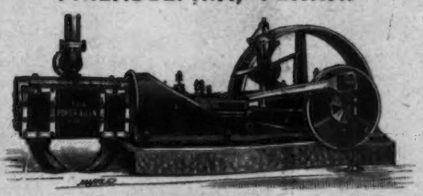

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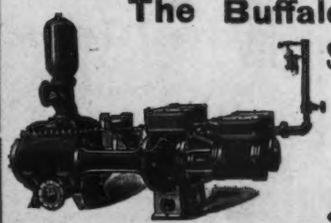

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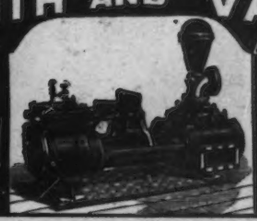

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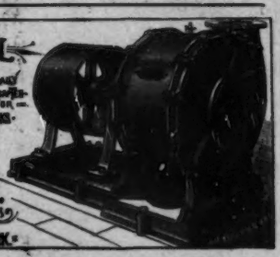

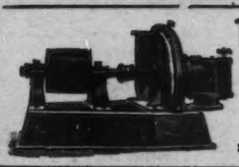

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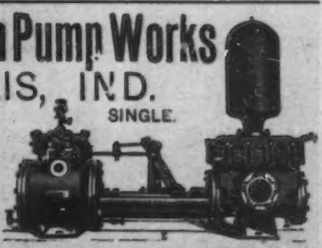

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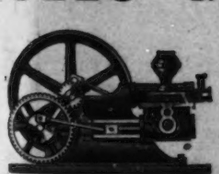

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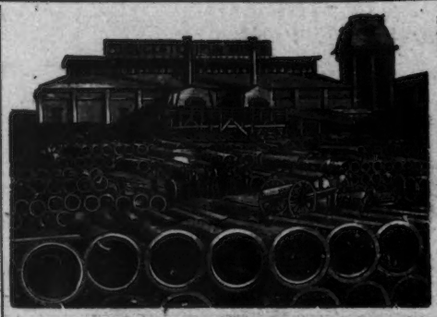

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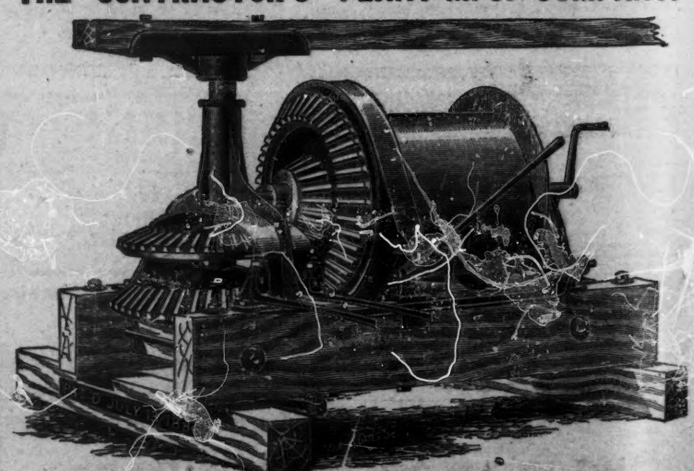

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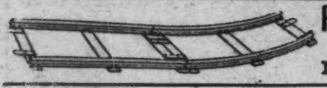
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BALTIMORE, Aug. 9, 1888.
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Tests made under Col D. C. HOUSTON, Corps of Engineers, U. S. A., of Alsen's Cement used for sea wall around Governor's Island, New York Harbor.
Tensile strength per square inch, 1 day, 384 lbs.; 7 days, 600 lbs.; 30 days, 818 lbs.
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STEEL RAILS.

STANDARD SECTIONS	50	TO	80	LBS.	PER YARD.
LIGHT	16	TO	45	"	" "
STREET RAILS	30	TO	88	"	" "

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THE BARBER ASPHALT PAVING CO. — GENUINE TRINIDAD ASPHALT — TRADE MARK

THE BARBER ASPHALT PAVING COMPANY.

The extent of pavements laid by this company prior to Jan. 1, 1891, is as follows:

Cities.	Sq. Yds.	Cities.	Sq. Yds.
Washington	807,701	Erie	99,962
Baltimore	31,188	Youngstown	23,177
Philadelphia	81,864	Fort Wayne	16,399
New York	197,816	Chicago	129,849
Long Isl'd City	1,721	Omaha	431,517
Newark	13,429	Denver	7,833
Boston	45,225	St. Joseph	120,363
Albany	57,159	Topeka	194,633
Schenectady	9,362	Kansas City	106,606
Lockport	13,701	Wyandotte	29,652
Buffalo	1,547,385	Wichita	56,176
Scranton	106,003	St. Louis	86,251
Wilkesburre	83,888	Louisville	125,494
Harrisburg	42,159	New Orleans	151,347
Altoona	33,789		
Dunkirk	909	Total	4,653,061

Or an equivalent of 307 miles of roadway, 26 ft. wide.

For plans and estimates apply to the general offices of the Barber Asphalt Paving Company: A. L. BARBER, President, Le Droit Building, Washington, D. C. E. V. GREENE, Vice-President, Washington Building, 1 Broadway, New York.
Washington, 16 Le Droit Building; New York, 1 Broadway; Philadelphia, 33 North Thirteenth St.; Boston, 13 Pearl St.; Buffalo

ITS ADVANTAGES:
Durability, Smoothness, Health, Safety, Noiselessness, Popularity, Cheapness.

It is the only pavement which in this country can to-day show 307 miles of surface in first-class order. It is the standard pavement of America.

It will save 30 to 40 per cent. of the cost of transporting passengers and goods in any city.

It will save 50 to 75 per cent. of repair to vehicles.

It saves human nerves and health, and adds to the comfort of every person who uses a carriage.

This company has laid asphalt pavement in 35 cities of the United States, on 618 streets.
It has taken up other pavements and replaced them with Trinidad Asphalt Pavement to the following extent:

Wood	504,472 square yards
Stone	416,986 " "
French Rock Asphalt	32,196 " "
Coal Tar and Vulcanite	30,009 " "
Macadam	463,101 " "
Total	1,570,783 square yards.

The localities where this substitution has been made are noted in the preceding list of streets. The Barber Asphalt Paving Company has laid its Trinidad Asphalt Pavement upon Macadam, Stone block and Asphalt block founda tion to the following extent:

Upon old Macadam foundation,	95,118	sq. yds.
" Stone block "	88,859	"
" Asphalt " "	16,325	"
Total	200,302	"